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The construction industry and the environment

◆ Environmental impacts

◆ Sustainable building design and technologies

◆ Application of life cycle analysis to buildings

◆ On-site green technologies

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The construction industry: building for sustainability?

By providing housing and infrastructure, the construction industry makes a vital contribution to the social and economic development of every country. At the same time, this sector of industry – expanding apace in rapidly industrializing countries – has major impacts on the environment. Construction is an important consumer of non-renewable resources (energy in particular), a substantial source of waste, a polluter of air and water, and an important contributor to land dereliction.

This issue of *Industry and Environment* focuses specifically on the building industry, which is a part of the construction sector. According to experts from the Worldwatch Institute, one- tenth of the global economy is dedicated to constructing and operating homes and offices. In terms of materials, this activity consumes an even larger share: one-sixth to one-half of the world's wood, minerals, water and energy. As a result, the responsibility for much of the environmental damage occurring today, including destruction of forests and rivers, air and water pollution, and climate destabilization, must be laid squarely on the shoulders of modern buildings. And many buildings do harm on the inside as well, as they may subject their occupants to unhealthy air or alienating physical environments.[1]

Environmental impacts occur at every stage of the construction cycle: siting, production and supply of building materials and equipment, on-site construction, operation and demolition.

New building developments, together with the quarrying of sand and gravel, the extraction of brick materials and clay, and the exploitation of timber resources, destroy natural areas, forests and wetlands.

The transport of building materials consumes large amounts of energy. Energy is also used in the production of key building materials such as cement, brick, glass, lime, steel and aluminium. Energy consumption at the production stage, as at every other stage in a buidling's life cycle, generates greenhouse gases and sulphur dioxide as well as emissions of dust, fibres, particulates and other air pollutants. Ore mining leaves behind huge tailing heaps which are potential sources of water pollution.[2] Wood preservation processes, used to protect timber from fungal and insect attack, are another major source of pollution.[3]

Longer-term environmental impacts result from the use and operation of buildings. It has been estimated[4] that one-third of global primary energy is used just to maintain existing structures and keep them running. A survey of water use in modern buildings tells a similar story, at a time of growing demand from all economic sectors for often scarce fresh water resources.

Finally, demolition generates massive amounts of waste to be disposed of, adding to the considerable quantities already produced at other stages – from quarrying and mining to building maintenance and operations.

But solutions to these problems exist. They involve careful siting and design of buildings, prudent choice and efficient use of building materials, re-use and recycling at all stages, the use of energy- and water-efficient building techniques and elements, as well as adequate maintenance and operation. As in many other sectors, solutions lie in cleaner-production approaches, ecoefficiency, new technologies, and new management practices and tools. The articles in this issue of *Industry and Environment* present examples of such approaches.

According to a number of world experts, achieving sustainability will require improving energy efficiency by a factor of ten within the next 30 to 50 years.[5] If the new cleaner technologies and practices already available in the construction sector were being widely used, it is estimated that energy consumption could already have been reduced by a factor of four.

One barrier to widespread use of environmentally-sound building technologies and innovation in the building sector is the broad range of decision makers and practitioners involved, including architects, urban planners, engineers, builders, developers, financing institutions, local authorities, and home appliance designers. Better understanding is needed of how decisions are made and how practices are adopted at each stage of the construction process, of how these decisions, processes and stages inter-relate, and of their consequences for the environment and long term sustainability.

The construction industry needs to adopt a more proactive attitude in regard to incorporating environmental considerations into its work, and to understand that building green means good business. Industry associations and companies should issue voluntary codes of practice, publish annual environmental reports, and monitor and publicize the environmental performance of various types of buildings.

Governments can also take steps to promote sustainable construction. They can adopt regulations, norms and standards stipulating minimum levels of environmental performance. They can also introduce incentives to orient choices towards sustainable building practices. All countries should give high priority to adequate pricing of energy to reflect global environmental impacts. Consumers should be made aware of the environmental performance of buildings and of the building industry, to allow them to make more informed decisions.

The UN conference Habitat II, held in Istanbul in June of this year, adopted a number of recommendations to promote sustainable urban development. The construction sector has a major contribution to make towards achieving this goal.

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[1] Worldwatch Institute, State of the World (1995), *"Making Better Buildings"*, Nicholas Lenssen and David Malin Roodman, p. 95.

[2] DDSMS/UNEP (1994), *Environmental Management of Mine Sites – A Training Manual (TR 30).*

[3] UNEP/FAO (1990), *Environmental Aspects of Industrial Wood Preservation – A Technical Guide (TR 20).*

[4] Worldwatch Institute, World Watch (November/December 1994), *"Our Buildings, Ourselves"*, David Malin Roodman and Nicholas Lenssen, p. 21.

[5] Carnoules Declaration, Factor 10 Club.

◆

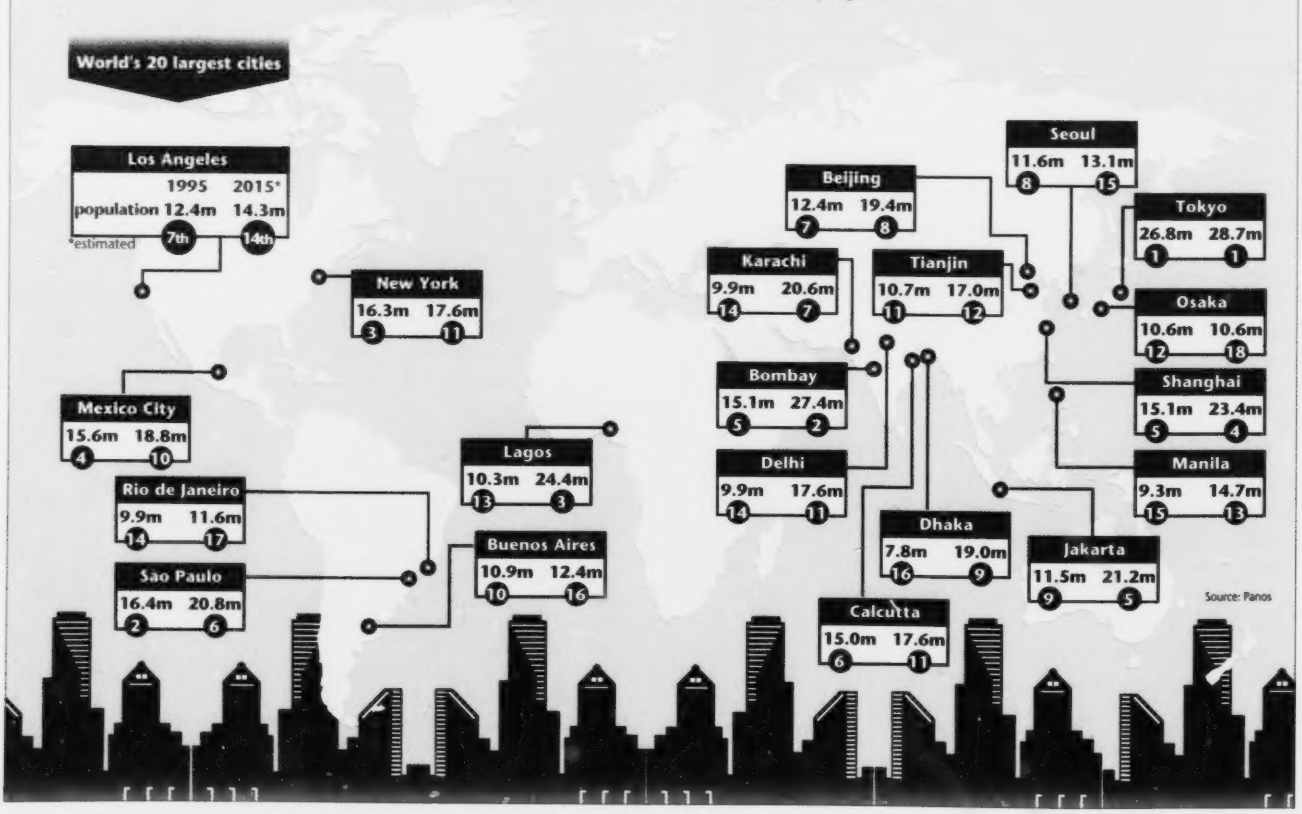
Construction and the environment: facts and figures

By 2025 the world's population will have risen by 50 per cent in relation to today's level and by that date two-thirds of the population will live in cities; almost all of the increase in population and urbanization will be in developing countries. Globally, the need for shelter and infrastructure which such developments create is shaping patterns of construction, and will continue to do so. **Figure 1** shows projected growth for cities; construction will follow these trends, developing in areas where populations are rising and where there is increasing urbanization, and stagnating or even declining in others. In its 1995 report, The European Construction Industry Federation forecasts a fall in activity of 0.2 per cent for Europe, as a whole, in 1996. This is in sharp contrast with the projected situation in many developing countries. In India, for example, there is a need for 41 million dwellings between 1991 and 2000, and around 4 million houses per year will have to be provided in the period between 2001 and 2021.

Although the term construction covers a wide variety of technologies and practices, on different scales, the activity can nevertheless be viewed as an industrial process. As in most industries, raw materials are obtained, there is a transformation process, waste is produced and, ultimately, the finished product has to be disposed of. In construction terms, this means: obtaining materials and transporting them to site; site operations; and, finally, demolition. **Figure 2** provides a model of this process, showing stages both upstream and downstream of the finished structure. At some of these stages construction impacts the environment directly, at others, the impacts are indirect, with the construction industry acting as a major consumer for other industries. Energy also flows through the process and is consumed at every stage. Very large amounts of energy are used in obtaining, transporting and assembling materials, and even greater amounts are consumed for operation and maintenance of the finished structures. The emissions arising as a result of this use of energy represent a major indirect impact of construction on the environment. This key element in understanding the construction/environment relationship is examined separately below.

The breadth of meaning of the term construction and the links which this implies with other major industries make the subject a complex one. No attempt has been made here to cover every aspect of the industry, nor to analyze all of the types of pollution shown in Figure 2. Instead, significant examples of the scale of the impact of construction on the environment are given, and some proposed directions for improvement are examined.

Figure 1
The urban future: city sizes in 1995 and 2015
The growth of cities will be the single largest influence on development in the first half of the 21st century.
Ten years from now, more than half the world's population will live in cities.
Nearly all the urban population increase will be in developing countries.


World's 20 largest cities
Los Angeles
1995
2015*
population 12.4m 14.3m
7th
14th
*estimated
New York 16.3m 17.6m 3 11
Mexico City 15.6m 18.8m 4 10
Rio de Janeiro 9.9m 11.6m 14 17
São Paulo 16.4m 20.8m 2 6
Lagos 10.3m 24.4m 13 3
Buenos Aires 10.9m 12.4m 10 16
Beijing 12.4m 19.4m 7 8
Seoul 11.6m 13.1m 8 15
Tokyo 26.8m 28.7m 1 1
Karachi 9.9m 20.6m 14 7
Tianjin 10.7m 17.0m 11 12
Osaka 10.6m 10.6m 12 18
Bombay 15.1m 27.4m 5 2
Shanghai 15.1m 23.4m 5 4
Delhi 9.9m 17.6m 14 11
Manila 9.3m 14.7m 15 13
Dhaka 7.8m 19.0m 16 9
Jakarta 11.5m 21.2m 9 5
Calcutta 15.0m 17.6m 6 11

Source: Panos

Raw materials

Construction uses many materials extracted from deposits in the earth's crust. Some of these, such as aggregates and filling materials, are used directly on site after simple processing (washing, grading, etc.), others are the raw materials for more complex manufacturing processes.

The quarrying and mining required to extract materials are sources of noise, dust, water and air pollution, and very large quantities of residual waste. Mining of copper, a metal widely used in construction, produced 1,500 million tonnes of "tailings", as these wastes are known, in 1995.

Quarrying and mining also use very large amounts of land throughout the world. It has been estimated that around 20 per cent of the land-conversion termed "for urbanization" is used for quarrying.

The quarried materials used in the highest proportions, by volume, are aggregates (the inert materials forming a substantial part of concrete, asphalt and roads) and filling materials (used for stabilization and foundations). **Table 1** shows figures for overall and per capita production of aggregates in some developed countries. Aggregate production is unreported in the national statistics of most developing countries but the UNCHS indicates that figures in excess of 1 tonne per capita are not uncommon.

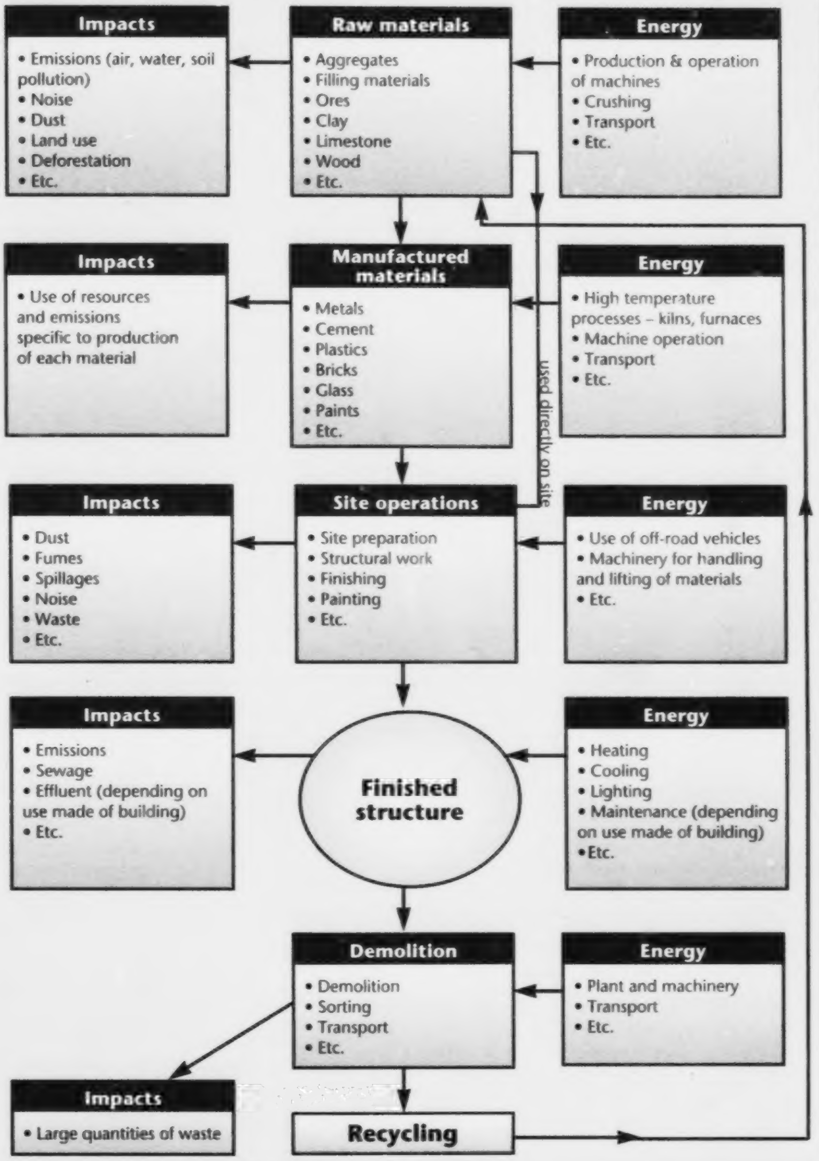
Aggregates are also obtained by removal of materials such as sand and gravel from coastal areas, frequently causing increased coastal erosion. Coral is sometimes used as an aggregate or building stone, especially in India and the Maldives; this practice is threatening delicate and irreplaceable ecosystems.

Some alternative materials exist which could partially satisfy demand. In particular, industrialized countries produce very large amounts of inert mineral waste, such as colliery spoil from coal extraction or other forms of mining and fly ash and furnace-bottom ash from power stations and blast-furnaces. Such materials are suitable for use as aggregate and fill material. The solution is attractive as it could provide a disposal route for large quantities of such wastes. About 100 million tonnes of colliery spoil are produced yearly in China and about 40 million tonnes in the UK. At present, about 20 per cent of this waste is used in construction in China, and around 10 per cent in the UK.

Construction, both traditional and modern, consumes large quantities of wood and more is likely to be used in the future. **Table 2** shows volumetric production of sawn timber from coniferous and broad-leaved trees. A large proportion of this timber is used by the construction industry. Given that a cleared hectare of forest yields 20 m^3 of sawn-wood, the figure for the world production of broad-leaf timber in Table 2 is equivalent to the clearing of around 6 million hectares, more than one third of the FAO estimate for total worldwide deforestation in 1990.

Worldwide, the construction industry is the principal user of tropical hardwoods and their products, contributing very substantially to the loss of tropical forests.

Figure 2
The construction process and related environmental impacts



Impacts
• Emissions (air, water, soil pollution)
• Noise
• Dust
• Land use
• Deforestation
• Etc.
Raw materials
• Aggregates
• Filling materials
• Ores
• Clay
• Limestone
• Wood
• Etc.
Energy
• Production & operation of machines
• Crushing
• Transport
• Etc.
Impacts
• Use of resources and emissions specific to production of each material
Manufactured materials
• Metals
• Cement
• Plastics
• Bricks
• Glass
• Paints
• Etc.
Energy
• High temperature processes – kilns, furnaces
• Machine operation
• Transport
• Etc.
used directly on site
Impacts
• Dust
• Fumes
• Spillages
• Noise
• Waste
• Etc.
Site operations
• Site preparation
• Structural work
• Finishing
• Painting
• Etc.
Energy
• Use of off-road vehicles
• Machinery for handling and lifting of materials
• Etc.
Impacts
• Emissions
• Sewage
• Effluent (depending on use made of building)
• Etc.
Finished structure
Energy
• Heating
• Cooling
• Lighting
• Maintenance (depending on use made of building)
• Etc.
Demolition
• Demolition
• Sorting
• Transport
• Etc.
Energy
• Plant and machinery
• Transport
• Etc.
Impacts
• Large quantities of waste
Recycling

Although, in principle, timber production could be made sustainable, a combination of economic necessity (the commodity is a major export for some low-income countries), commercial interest, population pressure and bad management is leading to loss of forests throughout tropical regions. The International Tropical Timber Organization estimates that, at present, less than 0.2 per cent of tropical forests are being managed in a sustainable way.

Table 1
Aggregate production for selected countries, 1989

Country	Aggregate production (million tonnes)	Tonnes per head of population
France	138	2.45
Japan	190	1.54
Rep. of Korea	46	1.07
UK	319	5.56
USA	1937	7.74

Source: United Nations Industrial Statistics Yearbook, 1989

It is not only major international logging interests which are depleting timber sources. In areas where wood is a traditional building material the pressures of increasing population and urbanization can cause crisis conditions in hitherto "renewable" sources. This has occurred in Bangladesh where bamboo is the main material used for walls and roofs in around 60 per cent of dwellings. In 1981 the natural resource was sufficient to meet the 0.8 million tonne annual demand. Population growth and urbanization have driven this demand up to 1.4 million tonnes per year and the country has experienced shortages.

Manufactured materials

The construction industry is a large consumer of energy-intensive, manufactured materials such as iron and steel for structural elements, copper for plumbing and electrical conductors, glass for windows, and synthetic materials for sealing and insulation. It has recently been reported that the industry is the second largest user of plastics in Europe (after packaging), and it is expected that consumption, estimated at 5.1 million tonnes per year in 1992, will rise to 8 million tonnes per year by 2010.

Table 2
Sawn-wood production, 1989 for selected countries and world totals

Country	Sawn-wood production 1989 (million m^3)	
	Coniferous	Broad-leaved
World	373	124
USA	86	17
Former USSR	87	12
Canada	57	
Sweden	11	
Finland	8	
Brazil		10
India		14
Indonesia		10
China		9
Malaysia		8

Source: United Nations Industrial Statistics Yearbook, 1989

The environmental issues relating directly to the production of these materials are, of course, matters for the industries which produce them. They are not specific to construction. However, increasing awareness within the construction industry as to the environmental implications of choice of materials would allow the industry to examine its consumption patterns in a new light. This point is discussed further under "*Energy consumption and emissions*", below.

In using metals on a large scale, construction is contributing to depletion of non-renewable resources. While it is true that most of the metals used in construction are not likely to be subject to shortage in the near future, this is not the case for all of them. **Table 3** gives the calculated available reserves for some metals widely used in construction. Significant quantities of copper (estimated reserve life 62 years) are used for plumbing and electrical conductors while zinc is widely used in developing countries for galvanizing of roof sheets. As commodities become rarer, their price tends to rise. In the case of copper, this has led to increasing use of PVC for plumbing and of aluminium for electrical conductors. Since zinc supplies could be exhausted within 50 years, alternatives will have to be found.

Table 3
Consumption and reserves of some metals

Metal	Consumption 1990 (thousand tonnes)	Base reserve 1990 (million tonnes)	Base life index (years)
Aluminium (bauxite)	178,878 (A1)	24,500 (Bauxite)	225
Copper	10,773	550	62
Lead	5,544	120	36
Nickel	842	1098	116
Tin	229	6	28
Zinc	6,973	295	40
Iron ore	925,000	229,000	265

Source: World Resources Institute, 1992

Cement is a manufactured material used almost exclusively by the construction industry. It is also a source of pollution and a very large energy user. The most serious form of local pollution resulting from cement manufacture is airborne dust particles generated in the heating process and during quarrying, transporting and crushing of the limestone required for its production. This form of pollution can be controlled, at least at the production stage, by use of efficient filtering systems. **Figure 3** shows how this was effectively dealt with in France after the introduction of stringent legislation. Dust emissions dropped from around 200 thousand tonnes per year in the 1950s and 60s to very low levels by the 1990s even though production doubled during the same period. However, the cost of dust removal can be fairly high: around 15 per cent of the investment cost for a cement plant. Many plants are operating throughout the world without efficient filtering.

Table 4
Breakdown of primary consumption in the Netherlands (1990)

Material	Primary energy requirement (GJ/tonne)
Very high energy	
Aluminium	200-250
Plastics	50-100
Copper	100+
Stainless steel	100+
High energy	
Steel	30-60
Lead, zinc	25+
Glass	12.25
Cement	5.8
Plasterboard	8.10
Medium-energy	
Lime	3-5
Clay bricks and tiles	2-7
Gypsum plaster	1-4
Concrete:	
in situ	*0.8-1.5*
Blocks	0.8-3.5
Precast	1.5-8
Sand-lime bricks	0.8-1.2
Timber	0.1-5
Low-energy	
Sand, aggregate	<0.5
Flyash, THA, volcanic ash	<0.5
Soil	<0.5

Source: UNCHS, 1991a

Site operations

Construction site operations can be the source of a variety of environmental problems. Some of these, such as noise, dust and fumes, are temporary, though serious, nuisances. Others, such as spillages which contaminate soil or reach groundwater, can have more long-term effects.

The solution to these problems generally lies in improving site management and in adopting environmentally sound practices. The industry, in some parts of the world, is beginning to address these questions. In the USA, for example, the pressure of more stringent environmental regulations and the fact that construction companies have been held liable by courts for hazards resulting from their site practices, even after completion of buildings, are forcing the industry to take these issues seriously. A "Risk Management Procedures" manual produced recently by the Associated General Contractors of America gives a list of hazards for which contractors can be held liable after completion of site operations. These range from "lead paint emissions from bridge rehabilitation", through "emissions and spillages", to "construction or maintenance errors causing release of airborne bacteria and/or radon".

Dangerous substances may also be released by on-site working of materials, such as cutting and drilling of materials containing asbestos (in regions where this substance is still not banned). Asbestos can also be a serious hazard during retrofit work and, especially, during demolition where the presence of the material may not be known before starting work.

Operation

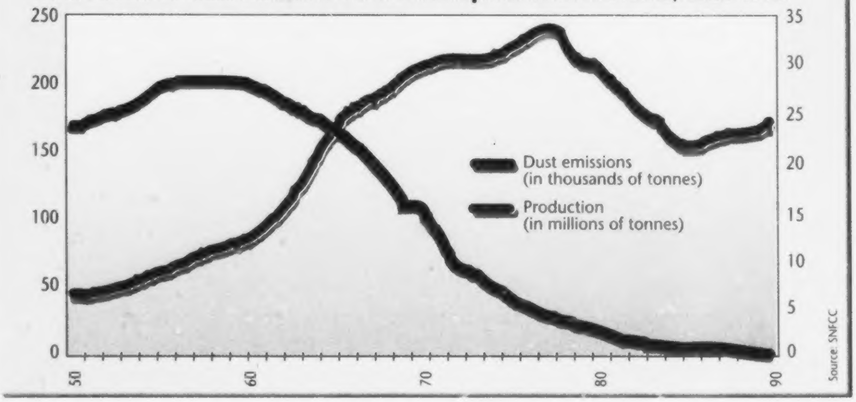
Buildings consume large amounts of energy for their operation and maintenance. In fact it has been estimated that as much as one-third of global primary energy is used for operation and maintenance of buildings. The fossil-fuels used to provide by far the greatest proportion of this energy are sources of emissions. Buildings also emit pollutants directly, in the form of sewage and effluents. Although these things are beyond the direct control of the construction industry – they depend on decisions made by building users – building design and construction techniques can, nevertheless, exert a strong influence. A large proportion of the energy consumed for building operation is used to maintain acceptable internal conditions, which basically means for heating and cooling. These are areas where design and technique can make very large differences. For example, optimum use of insulation and passive solar gains can cut heating demands dramatically in climates where this is appropriate. Many urban areas in low-income countries have low winter temperatures and therefore very high heating demands. In the Chinese capital Beijing, the average temperature in January is -4.6° C. In spite of this, the external walls of most of the buildings allow large quantities of heat to escape. They have U values (a measure of how much heat is allowed to escape) of 1.5 W/m^{2}K or more. New building regulations require maximum values of 1.25 W/m^{2}K. This is a modest improvement, but it will be sufficient to reduce fuel consumption for heating by as much as 30 per cent. As China currently burns 90 million tonnes of coal per year for urban heating, this substantial saving in fuel will mean a substantial reduction in emissions of greenhouse gases and sulphur oxides.

In the UK, the domestic sector consumes about 30 per cent of the energy supplied to all sectors, and around 60 per cent of that energy is used for space heating. Figures 4a and 4b show what can be achieved by energy-saving construction, in this case well designed insulation and double glazing in a temperate to cold climate. **Figure 4a** represents a poorly insulated house of the type of construction common in the UK in the 1970s. The net annual heating demand (i.e. the amount of energy required to maintain comfortable internal conditions) is 13,000 kWh per year. In **Figure 4b**, which represents a well insulated house with double glazing, this demand has fallen to 4,000 kWh per year. With so-called "superinsulation", using material 200 mm thick or more, the space heating demand could disappear almost completely. The "useful free heat" referred to in these figures is the contribution to heating from the normal activities within the building. The slight loss of useful solar heat (from 3000 kWh/year to 2000 kWh/year) is due to the presence of the insulation.

In areas where the primary need is for cooling, traditional designs favouring movement of air for ventilation are to be preferred to energy-consuming air conditioning systems. Inadequate maintenance of such systems is a source of direct release of CFCs to the atmosphere.

Many other areas of design need to be addressed if buildings are to become less wasteful in their consumption of resources. These extend from the structural aspects already mentioned to lighting systems, and to other aspects such as water consumption for sanitary appliances.

Figure 3
Reductions in dust emissions from cement production in France, 1950-1990



Source: SNFCC

Energy consumption and emissions

It has been estimated that 80 per cent of all of the energy required to produce a building is used in the production and transport of materials. The construction-site phase accounts for most of the remaining 20 per cent. The amounts of energy required to produce given amounts of materials (referred to as the energy intensity for the material) are known. **Table 4** gives the energy intensities for the most common construction materials and **Figure 5** shows the sorts of inputs which have to be considered even for a simple building.

Construction, as a major consumer of materials requiring large amounts of energy for their production, makes an indirect but very significant contribution to gaseous emissions, especially of carbon dioxide. Examples for four countries are given in **Table 5**.

Cement provides a good example of the scale of consumption and emissions associated with a widely used material. The high kiln temperatures and material crushing operations involved in cement production require very large amounts of energy. The 1.3 billion tonnes of cement produced in the world annually (1995 figure – Cembureau) accounts for around 1 per cent of the world's total primary energy consumption. Most of this energy is provided by burning coal (e.g. 2 Mt/yr in the UK), with consequent releases of carbon dioxide, sulphur dioxide and nitrogen oxides. Moreover, reactions within the kiln during cement production also release carbon dioxide, with as much as half a tonne of CO_2 being released for every tonne of cement produced. In Benin and Togo, cement production is the source of more than 30 per cent of carbon dioxide emissions.

Figure 4a
Contribution to the net space heating demand in normal houses – poorly insulated

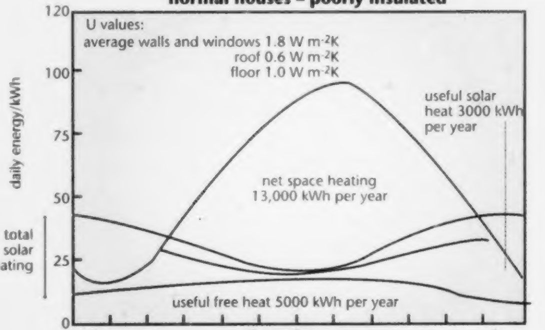
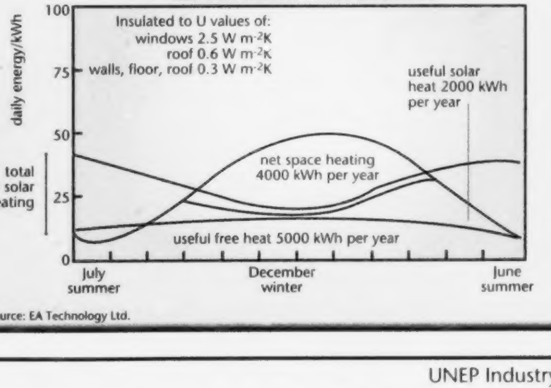


Figure 4b
Contribution to the net space heating demand in normal houses – well insulated



Source: EA Technology Ltd.

The cement industry is making efforts to address the problem of energy consumption, mainly through the use of alternative fuels, and improved processes and kiln design. A major step in this direction has been the conversion from a wet to dry production process. In the wet process, the ingredients are mixed with water to form a slurry, before being heated in the kiln. The development of a process where this mixing is not necessary has meant that the energy used to drive off the water is saved. Successful trials have also been carried out using industrial and agricultural wastes as substitute fuels, and these are progressively coming into use. The cement industry could thus become a disposal route for certain high-energy wastes.

Energy analysis is a tool which is increasingly being used by designers. Calculation of the energy required to produce a building, said to be "embodied" in it, provides designers with a quantified representation of the environmental burden which a project would represent, once realized.

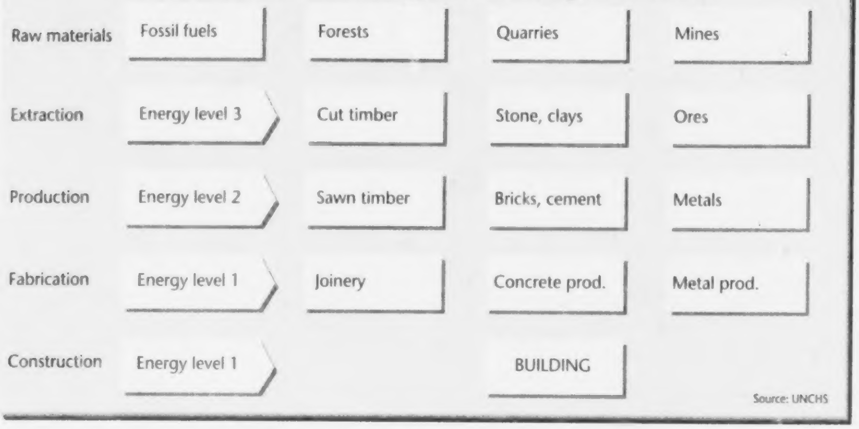
Table 6 shows an example of this embodied energy method used to compare three different types of housing in Argentina. It is also interesting to compare the figures given in this Table 6 with those in **Figure 6**, which shows embodied energy in housing in the USA.

Construction and demolition wastes

Even though they clearly result from very different stages in the life cycle of a building, construction and demolition wastes are usually classed together. Most of the heavy and bulky material generated is considered as inert, harmless waste and is usually sent for landfill. Available estimates put the amount of demolition waste generated every year in Western Europe at between 175 and 250 million tonnes (see **Figure 7**) and an estimate from the USA gives between 5 and 7 tonnes of waste from the building of a single-family house.

Although their proportions vary greatly from place to place, depending on

Figure 5
The levels of embodied energy use in building construction



Raw materials	Fossil fuels	Forests	Quarries	Mines
Extraction	Energy level 3	Cut timber	Stone, clays	Ores
Production	Energy level 2	Sawn timber	Bricks, cement	Metals
Fabrication	Energy level 1	Joinery	Concrete prod.	Metal prod.
Construction	Energy level 1		BUILDING	

Source: UNCHS

local methods of construction, C&D (construction and demolition) wastes break down roughly as follows:

- soil, stones and clay: these can be screened to separate them from other wastes;
- concrete and masonry: in principle, all of this can be recycled and reused;
- bricks: good quality bricks can be crushed for aggregate for low-grade concrete, high quality bricks can be cleaned and reused;
- wood: de-nailed timber and boards can be reused and unpolluted wood can be shredded for agricultural use. Painted or treated wood has to be considered as a hazardous waste and must be disposed of accordingly;
- metal: metals are recovered and recycled by the scrap metal industry in the same way as they are in other sectors of industry;
- others: such as plastics, paper, rubber, etc. The possibilities for recycling are low. Most of these wastes are disposed of in landfills or by incineration.

The problem of recycling of C&D wastes is complex. Composition will obviously vary from structure to structure, depending on the type of materials used in the construction process, and this inconsistency in supply means that the processes used for sorting and the possibilities for recycling also vary widely. There are also regional and national differences. **Figure 8** shows the proportions of composition for a part of the UK; the pie-chart for North America, where construction techniques use far more timber, would look very different.

The complexity of the process is well illustrated by the experience of the San Francisco authorities in clearing up after the earthquake in 1989. A major task was to remove the collapsed section of the Embarcadero Freeway. The fact that the firm awarded the contract was eventually able to sell 100 per cent of the recovered steel, wood, crushed concrete and even concrete dust was thanks to the sophistication of the plant used. The process included initial crushing of debris, removal of reinforcement bars and mesh by electromagnet, a whole series of further crushing and screening stages for separation and, finally, even a flotation system to separate wood splinters from the smallest fraction of concrete granules.

Good results are also being achieved in recycling bitumen recovered from road works and with asphalt roofing waste, used for road patching.

It seems likely that increasing rarity of landfill space, coupled with increasing demand for construction materials, will favour more recycling. Government actions, such as increasing charges for landfill disposal of construction wastes, will also provide incentive. Figures for global amounts of C&D wastes produced are difficult to obtain, but a "best wild guess" (*Industry and Environment* Vol. 17/2, pp. 26-27) put the annual amount for the world at 2 to 3 billion tonnes. If, as has been estimated, 30 to 40 per cent of this is concrete which can be fully recycled, the resource potential is considerable.

◆

Table 5
Carbon Dioxide emissions for selected countries, 1989

Country	Total CO_2 production (thousand tonnes)	Estimated proportion of CO_2 output (percentage)		
		Construction industry	Cement manufacture	Building use
Argentina	118,157	7.6	1.9	30
Germany	641,398	11.8	2.1	51
India	651,936	17.5	3.2	18
Kenya	5,192	11.9	11.7	25

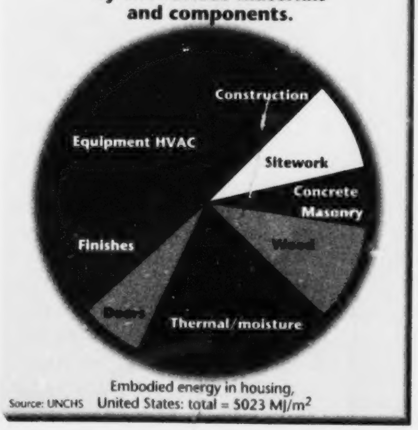
Source: World Resources Institute, 1992, Wells, 1986

Table 6
Comparative energy requirements for three single-storey houses in Argentina

House type	Embodied energy requirement (Mj/m²)
House made primarily with manufactured materials (hollow-brick walls, concrete frame and roof)	1,583
House made partly with manufactured materials (clay-brick walls, concrete frame, steel-sheet roof)	1,314
House made primarily with local materials (adobe walls, timber frame, steel-sheet roof)	590

Source: UNCHS

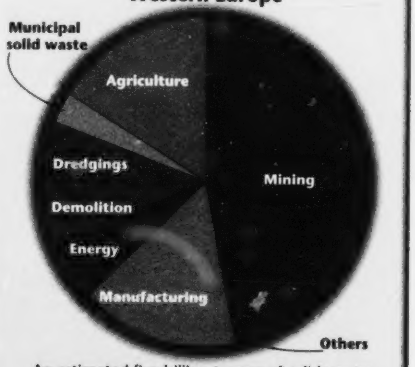
Figure 6
Breakdown of the embodied energy used in housing in the United States by the various materials and components.



Embodied energy in housing, United States: total = 5023 MJ/m²

Source: UNCHS

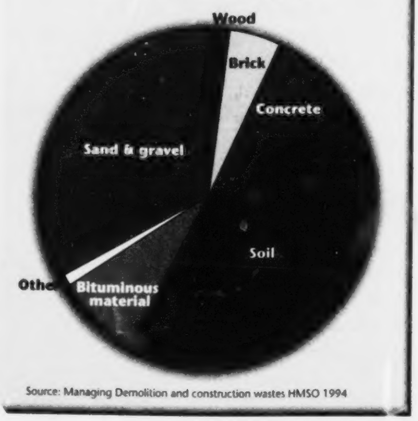
Figure 7
Solid waste generation in Western Europe



An estimated five billion tonnes of solid wastes is generated annually in Europe, the proportions of which are shown above

Source: P. White, M. Franke, P. Hindle - Integrated solid waste management

Figure 8
Relative proportions of components of construction and demolition wastes from sites in Surrey, UK



Source: Managing Demolition and construction wastes HMSO 1994

The construction industry and the environment in Europe

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Abstract

An overview is given of environmental issues facing the construction industry in Europe, together with some of the remedial measures put forward. The article is illustrated with specific examples of measures taken in some Member States of the European Union.

Résumé

L'article présente une vue d'ensemble des problèmes d'ordre écologique qui confrontent le secteur du bâtiment en Europe et considère certaines des mesures de redressement proposées. Les arguments présentés sont illustrés par des exemples de mesures adoptées dans un certain nombre d'Etats membres de l'Union européenne.

Resumen

El articulo presenta una visión general de los temas relacionados con el medio ambiente de cara al sector de la construcción en Europa asi como también algunas de las soluciones propuestas. En él se incluyen ejemplos específicos de la medicas adoptadas en algunos de los Estados Miembros de la CEE.

Introduction

Created in 1905, the European Construction Industry Federation (known as the FIEC) is the European founding member of CICA (Confederation of International Contractors' Associations). Through 28 national member federations in 22 countries (17 EU and EFTA countries, and the Czech, Slovak, Hungarian, Polish and Rumanian Republics), it represents construction firms of all sizes, carrying out all sorts of building and civil engineering activities. The FIEC ensures the promotion and defense of those interests that are specific to the construction industry.

The European construction industry is convinced that care for the environment is a challenge offering opportunities for innovation and the improvement of its image, efficiency and standard of quality. The market increasingly expects that the sector will take the environment into consideration. Therefore the construction industry accepts the challenge of trying to satisfy the expectations of all parties concerning sustainability and construction.

Environmental issues

The construction sector is confronted with many problems related to the environment. **Table 1** gives an indicative overview of the most significant of these problems. The aim of environmental policies is to prevent or reduce undesirable effects caused by human activities or operations. Policies in European Union Member States are, on the one hand, effect-oriented (based on concern for health and environmental impacts) and, on the other, source-oriented (based on concern for activities of society).

For the purposes of sustainability in construction, this implies the need to view buildings in their entirety, including health and environmental effects and the built environment.

Targets for the construction sector

From the standpoint of the foregoing philosophy, "sustainable building" is in principle directed towards integrated life-cycle management (reduction in the use of raw materials), reduction in the use of energy, and improvement in the quality of the building process. At the national level these three points are often translated into the following environmental targets for the construction industry:

- reduction in the use of finite raw materials;
- promotion of the use of secondary raw materials;
- volume reduction and separate collection of construction and demolition waste;
- promotion of the use of renewable raw materials;
- reduced use of building materials having a significant environmental impact, and phasing out of building materials with unsatisfactory environmental properties;
- conservation of energy for space and water heating in building; and
- implementation of environmental management systems.

Construction and demolition waste

In 1992 the European Commission set up the "Priority Waste Streams Programme" with six priority waste streams, including Construction and Demolition Waste. The Construction and Demolition Waste Project Group was set up in the same year. The Draft Final Recommendations Report proposed by the Project Group in 1995 presents a concise and detailed summary of recommendations and actions concerning the sector's waste (**Box 1**).

In the early 1990s, a number of EU Member States themselves started a dialogue with the main actors in the construction sector in order to participate in, and contribute to, the development of national waste management policies. National action programmes for Construction and Demolition Waste were developed from the point of view of prevention, recycling and reuse, as well as final disposal. These programmes are the outcome of cooperation between authorities, manufacturers, designers, builders and contractors. They include agreements and actions regarding education and training, legislation and regulation, building and civil engineering design, construction and demolition site management, waste treatment, transportation and disposal, and waste management planning.

Many waste recovery and prevention processes have already been developed and are successfully in operation. In several Member States there is increasing utilization of secondary materials, especially in road construction. In the same period construction enterprises have started the development and implementation of environmental management systems in their organizations. Eco-management, together with education and training, is acknowledged as an important aspect of achieving satisfactory levels of waste prevention.

Towards sustainability

Various aspects of "sustainable building" have been common practice in the construction sector for some time now. As regards the reduction of energy consumption, a great deal of progress has been made, for example in improving the efficiency of heating equipment. Since 1990, there have been further initiatives based on the concept of sustainable building in a number of Member States. On the practical side there have been a wealth of demonstration projects in the housing sector. Other initiatives have included the introduction of new, environmentally friendly products in construction. All these initiatives and activities are the result of cooperation between the various actors active in the construction sector.

Both government authorities and market actors realize that there are now opportunities for earning an excellent return in the near future on a relatively small investment. Therefore, joint policies to provide incentives for making the switch to sustainable building are being developed.

Box 1
Construction and demolition waste

The European Council Resolution of 7th May 1990 on Waste Policy considers that it is desirable, from the point of view of prevention, recycling and reuse, as well as final disposal, to establish action programmes for particular types of waste. It invited the European Commission to establish proposals for action at Community level.

In 1992, DG-XI of the European Commission set up the "Priority Waste Streams Programme" and, following consultation with the Member States, six priority waste streams programmes were initiated. These were: Used Tires, End-of-Life Vehicles, Chlorinated Solvents, Health Care Waste, Construction and Demolition Waste, and Waste from Electric and Electronic equipment.

The EU Fifth Action Programme on the Environment (Towards Sustainability) reflects the objectives and principles of sustainable development, preventative and precautionary and shared responsibility. In its resolution of 1st February 1993 approving the Fifth Action Programme, the Council advocated, particularly in relation to waste management, the elaboration of the concept of life-cycle management of products and processes in the most cost-effective way.

The Priority Waste Streams Programme represents a new approach to the development of Community policy. This involves the relevant industries being invited to participate in, and contribute to, the development of waste management policy. To facilitate the necessary consultations and discussions, the Construction and Demolition Waste project Group was set up in 1992.

The principal actors in the dialogue are the construction industry, as represented by FIEC, material producers, the recycling industry, and representatives of the EU Member States.

The primary objective of the Project Group is the elaboration of a list of recommendations. These recommendations will be evaluated by the European Commission and, where found appropriate, transposed into European legislation by means of a Regulation, a Directive, or merely a Recommendation.

The list of 49 recommendations contained in the Draft Final Report covers a wide range of objectives embracing waste prevention; the promotion of clean technologies; market transparency; subsidiarity; cost-effectiveness; and protection of the environment.

The draft recommendations call for recovery-oriented separation of construction and demolition waste as an essential element in achieving improvements in the recovery of resources from wastes. The report identifies a number of measures to achieve this: the employment of appropriately qualified organizations; permit systems relating to activities producing and transporting construction and demolition wastes; licensing systems for contractors engaged in the transportation of construction and demolition wastes; a Code of Practice relating to activities producing and transporting construction and demolition wastes; improving training of contractors engaged in construction activities producing and transporting construction and demolition wastes; and the implementation of return and collection systems for separated wastes

FIEC also introduced the concept of a construction and demolition permit where an inventory on wastes arising *and* the requirements on waste handling and removal are identified in the permit or contract specifications. Hence, the owner (or local or national authorities) clearly defines the waste handling requirements, permitting the contractor to include all relevant costs in his bid or charge accordingly. The introduction of education and training programmes on waste handling for contractors has also been proposed.

The recommendations of the DG-XI Project Group may contribute towards sustainable development for the environment whilst enhancing the role of the construction sector. The perspective for the contractor is positive, with a clear policy on waste handling, training and specifications.

References: Priority Waste Stream; Construction and Demolition Waste, March 1995, Cements Tracers Morgan/ANGUS commissioned by the Construction and Demolition Waste Project Group of DG-XI of the European Commission, FIEC Annual Report 1995.

Housing policy and legislation

Notwithstanding the various activities initiated in relation to the civil engineering sector, policy-makers and market actors in most Member States have discovered the opportunities of sustainable housing.

The extent to which a policy exists in the field of sustainable construction depends to a significant extent on the economic situation and the degree to which the primary requirement of a roof over everyone's head is met. More far-reaching policy on sustainable construction presupposes that the most pressing needs of the housing situation are met first. Seen from this angle, there are clear differences in policy and legislation between countries.

Virtually all countries have one or more sets of building regulations or other instruments for new dwellings. They concern, for the most part, insulation and standards for concentrations of radiation (radon).

As mentioned, emphasis in policy is placed on energy-saving in buildings as well as on materials. Practically all countries refer to one or more energy-saving measures. In most cases, levels are fixed for insulation in new construction. Subsidies are sometimes also granted for sustainable use of energy or housing improvements with a view to energy-saving.

A number of countries have also adopted policies for building and demolition waste with a view to reuse. Most countries have introduced a ban or at least a reduction in the use and continued presence of asbestos.

Regulations are widely used as a major instrument, especially regarding energy-saving and the internal environment. Financial instruments are widely used to keep existing dwellings in good shape generally. The objectives aimed at in just a few countries, such as water-saving, are promoted by less powerful instruments, such as voluntary (collective) agreements between relevant actors in the marketplace, as well as the dissemination of information.

Table 1
List of the most important environmental problems of concern to the construction industry

- Depletion of the ozone layer: use of insulation foam
- Climate change: use of energy while buildings are occupied
- Dispersion of material harmful to the environment: paints, thinners, wood preservatives and other construction materials/maintenance products
- Disposal of waste products: construction and demolition waste
- Waste: resource of primary raw material, use of water while buildings are occupied
- Indoor environment: construction materials

Many European countries offer subsidies to promote the construction of new dwellings. In most cases the subsidies also favour sustainability, notably energy conservation. In the same way the renovation of run-down dwellings and/or areas is promoted. Almost all European countries, in some degree or other, give assistance to experimental or demonstration projects and relevant research is subsidized. In most countries governmental authorities consult the building sector in regard to these initiatives. Consultations have resulted in agreements on specific subjects such as recycling and reuse of materials, energy conservation and legislation.

No clear, extensive "black" or "white" lists of building materials or construction in terms of sustainability exist as yet in most countries. It is said that market actors do not favour these kinds of lists. However, several initiatives do exist such as agreements between government and market actors to reduce the application of certain materials because of their impacts on health, safety and the environment (e.g. lead, chloride, asbestos). A "black list" could be said to exist in this sense.

In addition, attention is generally paid to promoting the reuse of materials (e.g. concrete aggregates). Recently the Netherlands has introduced an industry-wide basic voluntary package for sustainable building of new dwellings, which is strongly recommended by the national government.

Projects of this kind contribute to the aim of more rapid integration of sustainable construction into the mainstream of housing construction. However, to reduce the use of less environmentally friendly building materials, the development and investigation of a generally acceptable harmonized method of life-cycle analysis is strongly recommended.

Responsibility and liability

The construction industry invests in knowledge and technology in order to be able to construct in an environmentally sound manner. When public and private demand for environmentally sound construction products falls behind, these investments cannot be made profitable and care for the environment will suffer through increased competition.

Therefore, environmental awareness and the commitment of all parties – construction authorities, owners, developers, architects and designers, material suppliers, contractors, subcontractors, occupants and owners – is necessary. Environmental requirements should be adequately incorporated into standards, construction specifications and working documents. National and European standardization institutes have an important role to play in this respect.

European, national, regional and local authorities should try to achieve some degree of harmonization in their policies. Differences in the (application of) regulations are obstacles for the construction industry and distort fair competition, whereas uniformity may create social and economic inconsistencies in some regions.

The above mentioned conditions in the field of market acceptance and practical legislation/regulation can only be achieved through a constructive, genuine and cooperative dialogue between the construction industry, the authorities, and the occupants and owners.

Conclusions

The construction industry has a social responsibility in the field of the environment. The industry has the desire, the expertise and the experience to make an important contribution to the prevention, reduction and solution of environmental problems and to protecting the environment.

Challenges must be made to outweigh the threats through an active and constructive participation in the dialogue with authorities and other parties, such as occupants and owners.

“Sustainable building” offers benefits to all par-

Box 2
Selected housing examples

1. The Netherlands: National package for sustainable building

More and more professionals are turning to sustainable building, and each interprets the concept in his own way. All these different interpretations have given rise to a range of local arrangements and rules which can be inconvenient and inefficient. The National Package for Sustainable Building, an initiative of the Dutch construction industry, should put an end to this situation. The package is expected to become the standard for new dwellings.

The national package deals with all phases of the building process. It contains some 160 voluntary measures, arranged according to the phase and the environment to which they relate, from town planning to buildings and materials.

The measures relating to town planning cover the following topics: the landscape, the use of raw materials; techniques for collecting rainwater and surface water; different types of transport; the planning and use of green space in urban settings; and measures for restricting the use of energy derived from fossil fuels, for promoting the use of renewable sources of energy, and for designing an effective waste collection and storage system.

Those on buildings and materials cover the use of materials (based on a uniform list for common use), energy (measures for restricting the use of fossil fuel energy for space and heating purposes), water (measures for promoting water conservation), waste (the separation of construction and demolition waste, and techniques for separate storage and processing of domestic refuse) and health (measures to reduce radon levels and to remove lead piping from old houses).

2. Germany: Zero energy house in Darmstadt-Kranichstein

The house at Darmstadt-Kranichstein, the first “green” building to be erected in Germany, has fully met expectations regarding energy saving, comfort and air quality. Heat energy consumption of the building, erected in 1991/92 and comprising four dwelling units, has been around 12 kWh per m^2 in recent winters, 1/20th of the average consumption in Germany.

The essential design of the building is based on efficient thermal insulation (25 to 45 cm insulation thickness), optimum use of passive solar energy (heat-insulated triple glazing), and controlled ventilation with highly efficient heat recovery. However, the “green” house is not designed only to save heating energy. Energy efficiency, in this case that of the best domestic appliances on the market and a solar heating installation, reduce power consumption and the use of energy for hot water. The final figure for annual consumption for all applications in the household (heating, hot water, light, appliances, etc.) is approximately 30 kWh per m^2 of residential surface, equal to what the average German household consumes in domestic current alone.

The additional cost of this prototype of the “house without heating” in Darmstadt-Kranichstein was in fact approximately 20 per cent, compared with traditional housing construction. By using principles of economic construction and omitting the heating system, “economic green houses” will be achieved as a next step. They will be built at the average cost of new buildings in Germany.

3. Greece: “Energy 2001”

The National Action Plan for Energy Conservation in the Built Environment (“ENERGY 2001”), which has been carried out by the Ministry of the Environment, was applied through Specific Legislation concerning an Incentive Policy for Energy Saving Measures in Existing Buildings, as well as policies, policy instruments, measures and new standards concerning New Buildings in order to improve energy efficiency.

It was considered that an incentive-based policy, which promotes the Rational Use and Management of Energy, and also the use of Renewable Energy Sources could contribute in the medium and long term to a reduction in energy demand of up to 50 per cent.

The proposals pertain to measures for energy saving and the use of renewable energy by means of suitable techniques on the building envelope and the heating, cooling, DHW and lighting installations of existing buildings, as well as by means of energy-conscious and bioclimatic design of new buildings and urban settings.

The building was considered not only on an individual basis, but also as a part of the built-up environment, and thus the proposed measures cover both.

Furthermore, proposals were made for traditional protected-by-law buildings and settlements, with particular attention being given to the architectural and cultural heritage as well as traditional construction techniques and materials, thus proving that renewable energy technologies may be applied even in these areas.

Buildings of the public sector will constitute a “pilot” sector, where obligatory measures for energy saving and rational use of energy will be applied through interventions and techniques ranging from the conventional good housekeeping energy conservation techniques, for improvement of the thermal performance of the building, to much more radical energy-saving measures including the integration of renewable energy technologies. The obligatory character of these measures in public sector buildings will contribute to the implementation of suggested measures in order to monitor and evaluate their impact, thus permitting their adjustment and improvement prior to full-scale implementation. Priority and special attention have been given to intensive building types such as hospitals and educational establishments.

With respect to new buildings and new urban settings, the basic principles should be adhered to from the beginning of urban planning and building. Guidelines have been created so that the built environment can be harmonized with the natural one, reducing simultaneously the energy demand and environmental pollution.

ties. Uniformity in application will result in productivity gains for building contractors. Many users have a positive attitude towards buildings which have been designed and built based on environmentally friendly techniques. For suppliers and traders, the result may be increased demand for environmentally friendly materials. This means they must be in a position to respond swiftly and effectively to changing market needs. As a result, there may be a decline in the prices of environmentally friendly products as demand for them grows.

Information on sustainable building needs to be made uniform and more readily accessible. Secondly, there is a need to put into practice the concepts embodied by sustainable building and to ensure that the contribution made by sustainable building is a permanent one. Finally, account needs to be taken of future development of technical innovations, new products and building techniques by means of adequate collaborative preparation.

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Urban ecology: a holistic approach developed by Green City Denmark

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The aim of the urban ecology approach developed by Green City Denmark is to promote holistic solutions to environmental problems facing urban areas. Urban ecology focuses on a specific locality (house, neighbourhood, quarter or, possibly, whole town) and on a specific circle of citizens, as a basis for promoting sustainable urban development. The initiatives taken in different urban areas will depend on differences in infrastructure, buildings, culture, history, natural base and citizens' resources, etc.

In the spirit of the UN Brundtland Report (*Our Common Future*), Agenda 21, and the European Union's Green Book on Urban Ecology, Green City Denmark has compiled a database containing examples of urban ecology and associated work. The database is available to transfer knowledge to interested parties from abroad as well as to Danish consultants and authorities.

Four examples from Green City Denmark's database are given here. The database contains information on a number of other projects.

New dwellings with minimum resource consumption

Skotteparken in Ballerup (**Figure 1**) is a research and demonstration project with 100 attractive, good-quality dwellings.

Energy consumption for hot water and space heating is limited to 60 per cent by techniques such as additional insulation, low-emission window glass, conservatories, heat recycling from ventilation air, and solar heating for both hot water and heating. There is also a local combined heat and power plant with an advanced-technology control system.

Consumption of electricity is reduced, and water consumption is well below average levels.

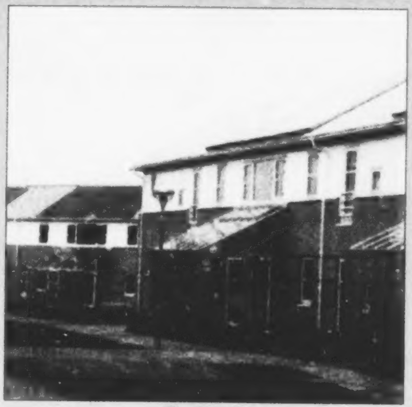

Figure 1

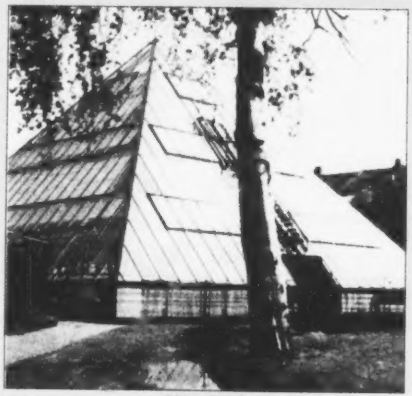

Figure 2

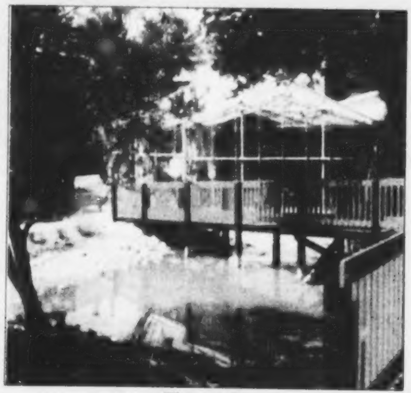

Figure 3

Ecological urban renewal

Kolding Municipality and the Danish Ministry for Housing are implementing an extensive ecological urban renewal research and demonstration project in the town centre (**Figure 2**). The overall aim is to develop a model for future town renewals, taking account of both ecology and resources.

The project area is a housing estate with 145 households. There are 36 renovated properties and two new buildings, each with its own resource (i.e. ecological) design concept. There are also outdoor areas which integrate ecological thinking into the urban idiom and a bio-works in which all domestic waste water is purified using microorganisms, plants and fish.

Mid-town nature area

Slagelse City Council and the Danish Ministry of Housing have carried out a project called "Green Urban Renewal", producing a green area which is an example of ecology-conscious design. The result is a lively mid-town "oasis" for the benefit of both adults and children (**Figure 3**).

The project incorporates several ecological themes:

- residents' participation;
- concerted selection of materials;
- solar energy using PV equipment;
- recycling and local reuse of rainwater;
- sorting of waste and composting;
- optimum conditions for plant and animal life;
- air and climate in the town; and
- cultivation and keeping of animals.

Business area based on sustainable design principles

The municipalities of Herning and Ikast have been involved in a joint project for the planning and preparation of a new business area, based on sustainable design principles (**Figure 4**). The first phase of the project covers around 75 hectares.

Companies moving into the area are to be several steps ahead of current Danish environmental standards. It is intended that they should become pathfinders for future ecological development in production and operation.

The zoning plan approved for the area is accompanied by a manual laying down of environmental guidelines.

Roads were built using recycled materials such as crushed concrete, crushed asphalt and waste slag. Surface water is purified naturally in "natural" rainwater basins.

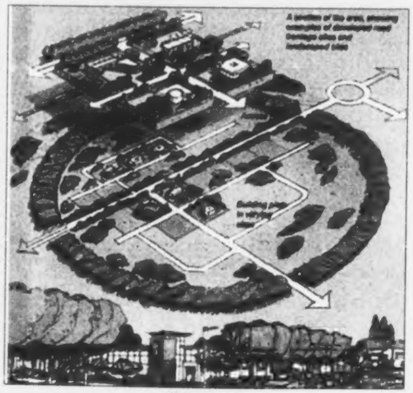

Figure 4

Environmental management systems in the attainment of sustainable construction in South Africa

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Abstract

Principles of sustainable construction are presented, to be used in practice by interested parties as a checklist. A multi-stage framework for the attainment of sustainable construction, which requires the application of Environmental Assessment (EA) and Environmental Management Systems (EMS), is updated: it is proposed that "Sustainability Assessment" might be a more appropriate term than use of the traditional "EA". The role of EMS in achieving sustainable construction is outlined and illustrated with reference to the three South African construction projects and the Shimizu Corporation, a Japanese construction company. In order to improve environmental management of construction, construction companies should become more active in developing organisation-wide Environmental Management Systems. For particular projects, more attention needs to be given to developing explicit environmental policy and to ensuring that the implementation of the EMS is audited at regular intervals.

Résumé

Les principes de construction durable sont ici présentés pour servir, dans la pratique, de liste de référence aux parties intéressées. Un cadre à étapes multiples, permettant la mise en oeuvre de la construction durable, qui nécessite l'application de l'Evaluation Environnementale (EE) et des Systèmes de Gestion de l'Environnement (SGE) est mis à jour : il est suggéré que l'expression « Evaluation de la Durabilité » pourrait être plus appropriée que la classique EE. Le rôle des SGE dans l'exécution de la construction durable est brossé et illustré par les trois projets sud-africain et la Shimizu Corporation, une société japonaise de BTP. Pour que la gestion environnementale de la constitution s'améliore, il faut que les entreprises du bâtiment s'attachent plus activement à la mise au point de Système d'Evaluation Environnementale. Pour les projets particuliers, il convient d'accorder plus d'attention à l'établissement d'une politique de l'environnement qui soit explicite, et de faire en sorte que la mise en oeuvre des SGE fasse l'objet d'un audit à intervalles réguliers.

Resumen

Se presentan los principios de una construcción continuada para que las partes interesadas los utilicen en la práctica como una lista de verificación. Se ha actualizado un sistema de múltiples etapas con el fin de conseguir una construcción sostenida, que requiere la aplicación de la Evaluación del Medio Ambiente (EA) y de los Sistemas de Gestión del Medio Ambiente (EMS): se propone que la 'Evaluación de Continuidad' podría ser un término más apropiado que el tradicional 'EA'. Se destaca el papel que desempeña la EMS en la consecución de una construcción sostenida y se lo ilustra haciendo referencia a los tres proyectos de construcción que tienen lugar en Sudáfrica y a la Shimizu Corporation, una compañía de construcción japonesa. Con el fin de mejorar las gestiones del entorno de la construcción, las compañías de este sector deberían ser más activas a la hora de desarrollar más ampliamente los Sistemas de Gestión del Medio Ambiente dentro de su organización. Y con respecto a la realización de proyectos particulares se debería prestar más atención al desarrollo explícito de la política ambiental y se deberían efectuar controles en intervalos regulares para asegurar la puesta en práctica de los EMS.

Introduction

Development efforts that seek to address social needs while taking care to minimise potential negative environmental impacts have been called sustainable development. The World Commission on Environment and Development (WCED, 1987) emphasised the importance of meeting the essential needs of vast numbers of people, and warned that a world where poverty and inequity were endemic would be prone to ecological and other crises. The WCED (1987) or "Brundtland" report described the concept of sustainable development as meeting the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising the ability of future generations to meet their own needs.

The concept of sustainable construction is of more recent origin and was proposed to describe the responsibility of the construction industry in attaining sustainability (Kibert, 1994). Sustainable construction is generally used to describe a process that starts well before construction, in planning and design, and continues after the construction team have left the site. Wyatt (1994) has deemed sustainable construction to include managing the serviceability of a building during its lifetime and eventual deconstruction and recycling of resources to reduce the waste stream usually associated with demolition.

Four attributes of sustainability – social, economic, biophysical and technical – have been identified to advance understanding of the concept of sustainable construction (Hill and Bowen, 1996). Because these attributes underpin and support the attainment of sustainability, they have been conceptualised as the four "pillars" of sustainable construction. Most of the literature on sustainability within the construction industry focuses on the biophysical environment and technical issues (see for example: Kibert, 1994; Roodman and Lenssen, 1994, 1995; Environmental Building News, undated; Loftness et al., 1994). Whereas this focus might be more appropriately termed "green" construction, the achievement of the ideals of the WCED (1987) requires that sustainability in construction include consideration of social and economic factors.

Principles of sustainable construction are summarised in **Figure 1**. Hill and Bowen (1996) recommend that interested parties involved in a project use the list of principles as a checklist, and then themselves determine which principles should be applied and the extent of application in a particular situation.

In order to implement the principles of sustainability, Hill et al. (1994a) have proposed a multi-stage framework for the attainment of sustainable construction. This framework requires the application of the following processes:

◆ Application of **Environmental Assessment** (EA) during the planning and design stages of projects, provided that EA is expanded to include assessment of all four "pillars" of sustainable construction and is undertaken in accordance with the process-oriented principles of sustainable construction. Although the term "environment" is often defined to include biophysical (or eco-

Figure 1
Principles of sustainable construction

PROCESS-ORIENTED PRINCIPLES OF SUSTAINABLE CONSTRUCTION

Overarching principles indicating approaches to be followed in evaluating the applicability and importance of each "pillar", and its associated principles, to a particular project.

- Undertake prior assessments of proposed activities
- Involve people potentially affected by proposed activities in the decision-making process in a timely way
- Promote interdisciplinary collaborations and multi-stakeholder partnerships
- Recognise the necessity of comparing alternative courses of action
- Utilise a life cycle framework
- Utilise a systems approach
- Exercise prudence
- Comply with relevant legislation and regulations.
- Establish a voluntary commitment to continual improvement of performance.
- Manage activities through the setting of targets, monitoring, evaluation, feedback and self-regulation of progress.
- Identify synergies between the environment and development.

PILLAR ONE:
SOCIAL SUSTAINABILITY

- Improve the quality of human life, including poverty alleviation
- Make provision for social self-determination and cultural diversity in development planning
- Protect and promote human health through a healthy and safe working environment
- Implement skills training and capacity enhancement of disadvantaged people
- Seek fair or equitable distribution of the social costs of construction
- Seek equitable distribution of the social benefits of construction
- Seek intergenerational equity

PILLAR TWO:
ECONOMIC SUSTAINABILITY

- Ensure financial affordability for intended beneficiaries
- Promote employment creation and, in some situations, labour intensive construction
- Enhance competitiveness in the marketplace by adopting policies and practices that advance sustainability
- Use full-cost accounting and real-cost pricing to set prices and tariffs
- Choose environmentally responsible suppliers and contractors
- Invest some of the proceeds from the use of non-renewable resources in social and human-made capital, to maintain the capacity to meet the needs of future generations

PILLAR THREE:
BIOPHYSICAL SUSTAINABILITY

- Extract fossil fuels and minerals, and produce persistent substances foreign to nature, at rates which are not faster than their slow redeposit into the Earth's crust
- Reduce the use of the four generic resources used in construction, namely, energy, water, materials and land
- Maximize resource reuse and/or recycling
- Use renewable resources in preference to non-renewable resources
- Minimise air, land and water pollution at global and local levels
- Create a healthy, non-toxic environment
- Maintain and restore the Earth's vitality and ecological diversity
- Minimise damage to sensitive landscapes, including scenic, cultural, historical and architectural

PILLAR FOUR:
TECHNICAL SUSTAINABILITY

- Construct durable, reliable and functional structures
- Pursue quality in creating the built environment
- Use serviceability to promote sustainable construction
- Humanise larger buildings
- Fill in and revitalise existing urban infrastructure with a focus on rebuilding mixed-use pedestrian neighbourhoods

Source: Hill and Bowen, 1996

logical), social and economic factors, it may be extending the use of the term "environmental assessment" too far to include technical and financial considerations (which is common practice in EA). Thus, a "**Sustainability Assessment**" might be a more appropriate term than use of the traditional "EA". This would overcome many semantic problems where some use the term "environmental" as separate from social and economic factors, although strongly linked (Goodland, 1995), and others use the term in an inclusive way (Department of Environment Affairs, 1992).

- Implementation of **Environmental Management Systems** (EMS), as described in the specification prepared by the International Organisation for Standardisation (ISO, 1995), within construction organisations, and for each project, during construction, operation and, where appropriate, even decommissioning. Using the same argument outlined above, "**Sustainability Management Systems**" might be a more appropriate term to describe the ambit of these management actions.

The framework and its components are summarised in **Figure 2**, using the traditional terms of EA and EMS.

The remainder of this article outlines the role of EMS in achieving sustainable construction, with reference to three South African civil engineering projects. The focus of most efforts to achieve sustainable construction in South Africa to date has been through the evaluation of alternative sites to avoid sensitive environments and management of the on-site environment during construction. Although many of the principles of sustainable construction have not yet been applied on a systematic basis in South Africa, the South African projects are used as illustrations to facilitate understanding of the application of EMS in construction. Where South African examples are not available, the approaches adopted by the Shimizu Corporation (Miyatake, 1994), a Japanese construction company, are used as illustrations.

There are few references to the use of EMS in construction, with two notable exceptions being papers by Miyatake (1994) and Boye-Moller and Larsen (1994).

Environmental management systems applied to construction

In South Africa, most formal Environmental Management Systems (EMS) instituted to date have been implemented by large industrial or business organisations. The environmental management that has been implemented in a few major South African construction projects did not, in most cases, initially use an EMS specification for guidance. Examples of EMS specifications include the "Code of Practice for Environmental Management Systems" published by the South African Bureau of Standards (SABS, 1993) and the international specification for EMS developed by the International Organisation for Standardisation (ISO, 1995). Such specifications provide comprehensive checklists that should improve the practice of environmental management of construction.

Implementation of Environmental Management Systems as part of a framework for attaining sustainable construction starts with the adoption of an EMS within a construction organisation. This organisation-wide EMS would make provision for the application of project specific EMS for each new construction activity. After construction, when a facility is handed over to a client, a new organisation usually takes over management of the facility and yet another EMS could be developed to deal with the operation of the facility. A final EMS could be developed, where appropriate, for facility decommissioning. The chosen focus in this paper is on the environmental management of the construction process.

The components of a generic EMS for construction projects are presented as part of Figure 2. In order to ensure implementation of environmental management during a construction project, these components should be documented as requirements in the contract specifications and bills of quantities. The EMS components, grouped under four key requirements for the sake of clarity, are outlined below and illustrated with reference to the three South African construction projects and the Shimizu Corporation.

The first South African project concerns the construction of the Palmiet Pumped Storage Scheme in the Western Cape. This project entailed the development of two dams, linking pipes and a 400 Megawatt power station. The Palmiet scheme was one of the first large construction projects in South Africa where comprehensive environmental management was required of the contractors, primarily because parts of this development were constructed in a botanical reserve characterised by pristine *fynbos* (Afrikaans for "fine bush") vegetation. The initial feasibility study for the scheme was concluded in June 1979 and construction was completed in 1987.

The second South African project concerns the construction of a new aluminium smelter in Richard's Bay, on the north-east coast of South Africa. This project entailed the expansion of the current operations of Alusaf, with the building of a new Hillside Smelter and upgrading of the existing Bayside Smelter. These developments more than tripled the previous production output of the company. Construction work on the Hillside Smelter was started in June 1993 and was completed in 1996.

The third South African project pertains to the reconstruction of a 13 km stretch of national road through the Du Toitskloof Valley, situated approximately 100 km from Cape Town. As part of this development, two bridges were constructed across the Molenaars River. Besides being scenically beautiful, this valley hosts relatively pristine *fynbos* and is drained by the Molenaars River that, due to exceptional water quality, was declared by the Department of Water Affairs as a Special Standards River in 1984. Road construction commenced in 1993 and will be completed in 1996.

The following sections outline each of the four key requirements of an EMS, using the above-mentioned projects as illustrations.

Key EMS Requirement 1: Environmental Policy

The first key requirement in developing an EMS is to determine an environmental policy to judge all the activities that are to be managed. Such a policy would set the desired level of environmental performance. Construction organisations could adopt a general environmental policy that could inform policies for specific projects. For instance, Shimizu Corporation, a Japanese construction company, adopted a Global Environmental Charter in 1991 (Miyatake, 1994). This Charter commits the company to six key policies that include "evaluating environmental impact at each stage of construction", and "harmonisation with the community". At the level of individual construction projects, environmental policy would emanate from: company policy, if available; relevant legal requirements; and, the Environmental Assessment for the project that would identify those principles of sustainable construction deemed relevant to the project.

South African examples of policies for individual construction projects include various commitments to effective environmental management. In the Hillside Smelter project, for example, the Alusaf company committed itself to "minimising adverse impacts and maximising the benefits of both the Hillside and Bayside smelters on the natural, social and working environments" (Hill et al., 1994b). Another policy, specifically for the construction phase, indicates that Alusaf will "prevail upon contractors to give preference to the employment of local contractors" (Hill et al., 1994b). In the Du Toitskloof road project, a commitment was made to "ensure that the visual and ecological integrity of the valley is maintained" (Hill Kaplan Scott, 1993). Environmental mission statements have also been required from contractors tendering for a contract.

Key EMS Requirement 2: Organisational Structure

The second key requirement of an EMS is to provide an organisational structure and to determine the responsibilities, authority, lines of communication and the resources needed to implement the EMS. At company level, this could necessitate, *inter alia*, a number of committees, each constituted to address a particular environmental issue. For example, in 1994 the Global Environment Committee of Shimizu Corporation had a subcommittee that had been tasked with reducing the usage of tropical wood composite boards for concrete form work. Another committee was tasked with research and development of waste disposal technology (Miyatake, 1994). At the level of a particular construction project, a range of different organisations interact in the undertaking, and an EMS would need to define the required interactions between the various contractors, consultants and clients involved in the project. Similarly, lines of communication should link the organisations involved, and should also provide a connection with a range of interested and affected parties external to the construction process.

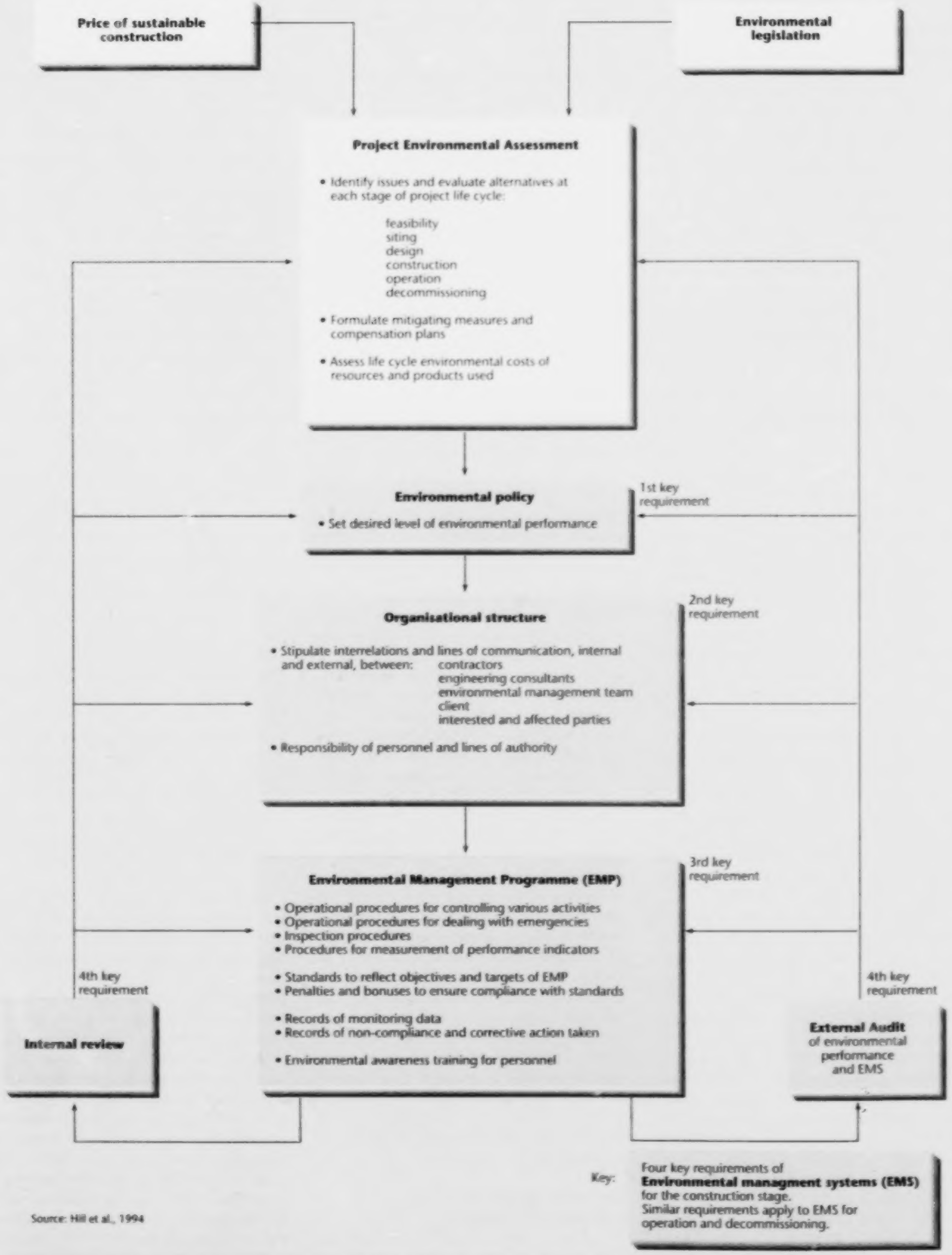
Two levels of organisational structure have been observed in the environmental management of the three South African construction projects under discussion. At a strategic level, an environmental management committee was constituted to review all environmental issues on a regular (usually monthly) basis and effect appropriate action. At the level of implementation, an environmental officer (EO) was tasked with ensuring ongoing adherence to an Environmental Management Programme. These procedures are common practice where environmental management is applied to construction projects in South Africa.

In the case of the Hillside aluminium smelter, the environmental management committee included company area and construction managers, the site resident engineer and appointed environmental specialists (Hill et al., 1994b). For the Du Toitskloof road project, the committee was composed only of environmental specialists (Carter and van den Honert, 1994), but met on a monthly basis at environmental site meetings with the client and the site personnel of the consulting engineers (Hill et al., 1994b). A representative of the Du Toitskloof committee was also present at the monthly construction site meetings with the client, contractor and site engineer.

Day-to-day responsibility for environmental management is usually the responsibility of the site consulting engineer, who is advised by the EO on an ongoing basis and at regular (usually weekly) meetings. Typically, the EO has no executive powers. In addition to the EO, specialists may be employed to monitor specific aspects of the environment. In the Du Toitskloof project, for example, a freshwater ecologist was employed to monitor water quality and aquatic life of the river.

Another important aspect of organisational structure is to communicate environmental issues internally to personnel within the company and externally to interested and affected parties (I&APs). In the Hillside smelter project, ongoing liaison was undertaken with I&APs through the staffing of a visitors' centre, presentations, site visits, and the bimonthly distribution of a newspaper. Similarly, in the Du Toitskloof project, signboards

Figure 2
A framework for sustainable construction



Price of sustainable construction
Environmental legislation
1st key requirement
2nd key requirement
3rd key requirement
4th key requirement
4th key requirement
Internal review
External Audit of environmental performance and EMS
Key:

Project Environmental Assessment

- Identify issues and evaluate alternatives at each stage of project life cycle:
  - feasibility
  - siting
  - design
  - construction
  - operation
  - decommissioning
- Formulate mitigating measures and compensation plans
- Assess life cycle environmental costs of resources and products used

Environmental policy

- Set desired level of environmental performance

Organisational structure

- Stipulate interrelations and lines of communication, internal and external, between:
  - contractors
  - engineering consultants
  - environmental management team
  - client
  - interested and affected parties
- Responsibility of personnel and lines of authority

Environmental Management Programme (EMP)

- Operational procedures for controlling various activities
- Operational procedures for dealing with emergencies
- Inspection procedures
- Procedures for measurement of performance indicators
- Standards to reflect objectives and targets of EMP
- Penalties and bonuses to ensure compliance with standards
- Records of monitoring data
- Records of non-compliance and corrective action taken
- Environmental awareness training for personnel

Key: Four key requirements of **Environmental managment systems (EMS)** for the construction stage. Similar requirements apply to EMS for operation and decommissioning.

Source: Hill et al., 1994

were erected on site detailing environmental concerns, regular meetings were held on an *adhoc* basis with I&APs, and an environmental newsletter was distributed to management staff on a monthly basis. In addition, the public were able to initiate contact with the environmental management committee through the EO at any time.

Key EMS Requirement 3: Environmental Management Programme

The third key requirement of an EMS is to develop an environmental management programme (EMP) that stipulates environmental objectives and targets to be met and work instructions and controls to be applied in order to achieve compliance with the environmental policy. For example, the Shimizu Corporation has set targets for three different types of construction waste. The reduction target for mixed waste is 70% of the 1990 volume in the year 2000, and other targets are provided for concrete debris and construction sludge (Miyatake, 1994). At the level of particular projects, the EMP would contain procedures that include: work instructions for defining the manner of conducting an activity; inspection procedures to ensure that mitigating measures are applied; procedures for dealing with accidents and emergencies; and procedures for the measurement of performance indicators, for example accidental and controlled release indicators and site impact indicators. Documentation plays an important role in the implementation of an EMP: in addition to an environmental management manual describing procedures, records should be kept of the monitoring data collected to test the effectiveness of mitigation measures and impact controls. Data collected to monitor performance indicators would be compared with standards chosen to reflect the objectives and targets of the EMP. These standards should be quantified as far as possible to facilitate verification of objectives. In construction, where the primary goals of the contractor and the environmental management committee may differ, the EMP may need to rely on penalties and bonuses to ensure compliance with standards. Records should also contain details of incidents of non-compliance with stipulated policy and standards, and should describe corrective action taken. Records should also be kept of environmental training activities.

All three of the South African projects under discussion implemented an Environmental Management Programme. In terms of the management of various activities, each of the projects sought to facilitate communication and minimise environmental problems. Sensitive areas were demarcated, techniques were developed to reduce water pollution of associated rivers and streams, and disturbed areas were rehabilitated in an ongoing process.

In the Palmiet Pumped Storage Scheme, an Environmental Impact Control Plan was prepared by the environmental consultant (Ekokonsult, 1983). The construction site was subdivided into 14 areas and each area was considered separately in terms of: the construction activities pertaining to that area; the effect of each activity on the environment; and, the construction guidelines applicable to that area. A fifteenth section of the Control Plan described activities and guidelines applicable to the whole site. The guidelines were incorporated into the contract specifications by the consulting civil engineers (Goister, 1989).

The EMP for the Du Toitskloof road project obligated the contractor to provide written method statements detailing construction procedures prior to undertaking work on environmentally sensitive aspects of the contract (Carter and van den Honert, 1994). These procedures were then reviewed and discussed by the site engineer of the consultant, the EO and the contractor, and were formally approved by the site engineer. In addition, procedures were developed in both the Du Toitskloof project and the Palmiet Pumped Storage Scheme to deal with emergencies such as road accidents, fires, flooding and major pollution events.

In order to ensure compliance with construction guidelines, specific inspection procedures were drawn up in all three projects. These procedures required the EO to undertake routine site inspections to check that various components of the EMP were being effectively implemented and to ensure that the environment was not being damaged from unplanned incidents. For example, in the Palmiet project off-site sources of quarried material were inspected to ensure that there were no seeds of invasive plant species present in the material.

Procedures for the measurement of environmental performance indicators require the setting of standards for relevant environmental parameters and ongoing monitoring. In the case of the Du Toitskloof road project, it was specified that samples be taken of both river water quality and the abundance of aquatic invertebrates. In doing so, both short term and long term changes in the health of the river system were adequately determined. The Hillside smelter project developed procedures for monitoring meteorological conditions, ground water quality, site runoff, dust, noise, site aesthetics and waste management.

The compilation and analysis of monitoring records are undertaken to ascertain any significant environmental changes. All of the South African examples presented in this article required the systematic recording of measurements and the subsequent analysis of data. In the Hillside smelter project, each monitoring requirement was detailed separately with a procedure, variables and data recording and reporting proformas.

In all three projects, standards were determined on site by the EO and, depending on the environmental parameter, based on either site-specific, national or international standards. In the Du Toitskloof project, for example, the pH of discharges into the Molenaars River was required to be between 5 and 7, where the natural pH of the river is between 5.2 and 6.4. In many situations, however, standards cannot be based on quantitative levels alone, and in such situations discretion is exercised by the EO and the site engineer as to what constitutes adequate performance.

The Du Toitskloof road project used penalties and bonuses to ensure compliance with environmental standards. The EMP imposed penalties on the contractor for the unnecessary removal of, or damage to, indigenous vegetation. A system of penalties imposed on a sliding scale from R2 000 up to R100 000 (US$1=R4.50) per event was also implemented if the contractor polluted the Molenaars River or any of its tributaries. Because of the difficulties of working in this environment and avoiding pollution, and the cost implications of such restrictions on the contractor, this project also implemented a series of bonuses. The EMP specified a bonus of R10 000 to be paid for every month in which the contractor worked in sensitive areas and adhered to the standards for water quality.

With the exception of the management representative charged with implementing an EMS and those carrying out specialised environmental management functions, many of the personnel within the implementing organisations would need exposure to environmental awareness training. Training programmes are typically designed and implemented by the EO. For example, in the Palmiet project a training programme was prepared which included an audio-visual presentation for the education of all construction staff, and a series of lectures and outdoor hikes. Similarly, in the Du Toitskloof project, an ongoing environmental education programme was implemented. In this case, the contractor was contractually bound to make time available each month for staff to attend the programme.

Key EMS Requirement 4: Environmental Audit

The fourth key requirement of an EMS is to undertake periodic audits of environmental performance and the effectiveness of the Environmental Management System. An audit report provides an essential information feedback loop to senior management who can then take corrective action to address the identified weaknesses of the EMS. Auditing of an EMS for a construction project could be done internally by the environmental managers or externally by a consultant. Typically, an external audit would be preferred for a large construction project of extended duration with potential to cause significant environmental impacts. The results of company-wide and project-specific environmental audits could be incorporated in the annual report of a construction company, which could eventually evolve into what UNEP (1994) has called annual "sustainable development reporting".

Little provision has been made in South African construction projects for the formal audit of environmental performance. Of the three projects examined, only the Hillside smelter scheduled procedural, technical, and environmental audits.

Conclusions and recommendations

Principles of sustainable construction are divided into four "pillars" – social, economic, biophysical and technical – with a set of over-arching, process-oriented principles, to be used in practice by interested parties as a checklist. A multi-stage framework for the attainment of sustainable construction, which requires the application of Environmental Assessment (EA) and Environmental Management Systems (EMS), is updated: it is proposed that "Sustainability Assessment" might be a more appropriate term than use of the traditional "EA".

Most South African construction companies have not yet adopted Environmental Management Systems to improve their environmental performance. In certain projects, however, where the existing environment is seen as sensitive, environmental management seeks to ensure that all parties involved take responsibility for the environment. Of the South African projects documented here, only the Hillside smelter formally provided an environmental policy for construction, although statements akin to policy were implicit in the documentation of the Du Toitskloof road project. In terms of the provision of an organisational structure that stipulates interrelations between the various groups involved, all three South African projects provided for the involvement of an environmental management committee at a strategic level and an environmental officer at the level of implementation. In all cases, this officer had no executive power and reported to the site engineer. All three projects implemented an Environmental Management Programme (EMP), with the earliest, the Palmiet Pumped Storage Scheme, emphasising guidelines for construction activities and only the Du Toitskloof road project making provision for financial penalties and bonuses to ensure compliance with environmental performance requirements. The Hillside smelter was the only project that made provision for an external environmental audit to review the progress of the project at specified stages.

In order to improve environmental management of construction, construction companies should become more active in developing organisation-wide Environmental Management Systems. For particular projects, more attention needs to be given to developing explicit environmental policy and to ensuring that the implementation of the EMS is audited at regular intervals.

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Principles and challenges of sustainable design and construction

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Abstract

Sustainable building practices, which are a critical factor in addressing the environmental crisis, can also provide commercial builders with a competitive business advantage. To persuade the mainstream building community that this is so, however, requires making a compelling business case that quantifies the benefits of building for sustainability. Elements of sustainable design include site planning and construction management, materials selection, energy planning, waste management, air quality, and design for flexibility. Among the main issues facing advocates of sustainable building are the need for ongoing oversight by the design team; challenges related to partnership and collaboration; the need to bring costs as close to parity with those of traditional buildings as possible; and whether to deliver a message about eco-responsibility through the visible design.

Résumé

Pour les entrepreneurs, les pratiques de construction durable, facteurs capitaux pour la résolution de la crise, peuvent aussi constituer un avantage sur la concurrence. Toutefois, si l'on veut convaincre l'entrepreneur moyen du bien fondé de cette affirmation, il faut le faire chiffres à l'appui. Au nombre des éléments déterminant une architecture durable, on compte la planification des chantiers et la gestion de la construction, le choix des matériaux, la prévision des besoins énergétiques, les gestion des déchets, la qualité de l'air et une conception permettant une certaine flexibilité. Les principaux problèmes auxquels sont confrontés les partisans de la construction durable sont, entre autres, la nécessité que l'équipe conceptrice supervise l'intégralité du déroulement du chantier, les difficultés liées au partenariat et à la collaboration; la nécessité de ramener les coûts à un niveau aussi comparable que possible à celui des constructions classiques; et si l'on doit concevoir l'extérieur d'un bâtiment de façon telle qu'il porte un message d' «éco-responsabilité ».

Resumen

Las prácticas de construcción sostenibles, factor crítico para la gestión de la crisis medioambiental, también pueden brindar una ventaja comercial a los constructores comerciales. Sin embargo, para cambiar la tendencia de los constructores, se necesita presentar un punto de vista comercial contundente que demuestre los beneficios de construir de forma sostenible. Los elementos del diseño sostenible incluyen la planeación de las plantas y la gestión de la construcción, la selección de materiales, la planificación energética, la gestión de desechos, calidad del aire y diseño para la flexibilidad. Entre los principales problemas que tienen que enfrentar los defensores de la construcción sostenible se encuentran una mayor supervisión por parte del equipo de diseño; los desafíos relacionados con el trabajo en grupo y la colaboración; la necesidad de reducir la diferencia de costes con relación a las construcciones tradicionales; y decidir si se debe transmitir un mensaje sobre la responsabilidad ecológica a través del diseño visible.

Introduction

Human habitats – in a word, buildings – are major contributors to the environmental crisis through resource depletion, energy consumption, air pollution, and the creation of waste. Building construction accounts for 25 per cent of the virgin wood and 40 per cent of the raw stone, gravel and sand used worldwide each year. Globally, buildings consume 16 per cent of the water and 40 per cent of the energy used annually. Close to 70 per cent of the sulphur oxides produced by fossil fuel combustion are produced through the creation of the electricity used to power our homes and offices. Indoor air quality is inadequate in 30 per cent of buildings around the world. In the United States, about as much construction waste is produced as municipal solid waste.

Curiously, these eye-opening statistics have been largely overlooked by the media, which apparently view industries like chemicals and oil, which have long been magnets for their attention, as much more newsworthy. From one perspective this is understandable: buildings aren't "unnatural" in the same way chemicals are, and the transportation of building materials does not foul beaches and kill wildlife, as can happen with oil. But the relative inattentiveness of the press (which, incidentally, is bound to change eventually) does not lessen the extent to which human habitat contributes to the environmental crisis, nor does it reduce our obligation as members of the building community (and citizens of the world) to steer the industry towards sustainability. This duty is both moral – we have an obligation to provide future generations with a good environmental quality of life – and practical.

Sustainable building practices can create competitive advantage in the here-and-now. The mounting evidence regarding global climate change and a host of other issues leaves no doubt that an environmental imperative is at hand: sooner or later we will have to change our ways. But while our directions are clear, it is also true that old habits die hard. Much of the building industry is comfortable with established ways of doing business and resists the compelling logic of the environmental imperative. The challenge for ecologically forward-thinking segments of the building community, then, is to overcome this resistance and to create a market for sustainable design and building practices – and sooner rather than later, because "later" may be too late. Keys to persuading the mainstream building community to go green include a) public sector awareness, b) proving through both theoretical business cases and real-world projects that sustainable building does in fact create a competitive advantage, and c) gaining legitimacy through the support of one or more major mainstream developers.

Public sector initiatives

General Services Administrations at the federal, state and local levels are assessing how to incorporate environmentally responsible building practices into their facility construction programmes. In New York City, for example, which happens to be my base of operations, the General Services Administration is exploring the possibility of implementing a set of Environmentally Responsible Building Guidelines.

Building a case

Two New York City-based private sector ventures have taken upon themselves the challenge of educating the building community, both in the city and elsewhere. Healthy Properties, L.L.C. builds sustainable structures, provides consulting services to builders, owners and tenants on green building practices, and educates commercial real estate developers about the financial benefits of building and managing properties sustainably. An associated venture, Healthy Properties' Green Development Collaborative, brings together eco-sensitive architects, engineers, building scientists, ergonomists and others to conceive, design and build sustainable structures.

Mainstream support

Finally, and perhaps most importantly of all, a major commercial real estate developer, the Durst Organization, has announced plans to erect a 1.6 million square foot environmentally responsible multi-tenanted office building in the heart of the city's venerable Times Square area. Tishman Realty & Construction, one of the United States' leading construction companies and a multiservice international real estate company, has announced that it will be the builder for the Durst building.

In a separate project involving the United Nations Environment Programme (UNEP), Healthy Properties' Green Development Collaborative is the project manager for a special task force set up to refurbish UNEP's own modestly-sized New York City offices, in collaboration with Tishman Realty and Construction, the Business Coalition for Sustainable Cities, Fox and Fowle Architects, WMX Technologies (Recycle America), the Climate Institute, Green Seal, Levien and Company, and the UN's Building Management and Catering Services. Change is driven by powerful and influential "early adopters" whose early commitment helps to establish the superiority of the new approach. In the case of Durst and Tishman, their support will go a long way towards legitimizing the entire movement in the eyes of mainstream developers.

The elements of sustainable design

In many ways, the two sites occupy opposite ends of the commercial real estate continuum. Unlike the Times Square building, the UNEP headquarters at 2 UN Plaza is small (about 5000 square feet), it is not in a new building, and the rest of the building is not being renovated. Despite these important differences, many of the design, construction and maintenance issues are identical. This is because the same basic goal underlies all sustainable building projects. That goal, according to Dr Asher Derman, a building scientist and member of Healthy Properties' Green Development Collaborative, is to "increase the productivity of all resources – human, energy and material." In other words, whether the specific goal is to provide good indoor air quality, reduce energy consumption, or save on carting fees for waste, the basic objective is the same – to get more out of one's resources than one would otherwise have done.

Derman's formulation is especially useful because "productivity" is an economic term, and it is economics in the form of return on investment that makes the commercial real-estate world go round. To build a persuasive business case, sustainable building must be lifted out of the abstract moral sphere and into the world of hard dollars. The "productivity principle" plays out in six basic areas: 1) site planning and construction management, 2) materials selection, 3) energy planning, 4) waste management, 5) air quality, and 6) design for flexibility. Let's briefly examine each in turn. Sustainable design principles for site planning and construction management call for minimal intrusion into the site where a building is situated, both during construction and once the building has been completed. Design strategies run the gamut, from moving as little earth as possible to planting wildflowers (which only need to be cut once a season) instead of grass (over 20 cuttings).

Another aspect of environmental site design is aesthetic: the building should be integrated as much as possible into the surrounding landscape. "Buildings mustn't look as if they've dropped onto a location from outer space," says Josh Weinstein, a principal with SITE II, whose affiliated company, SITE Environmental Design, belongs to the Green Development Collaborative. In Times Square, where the Durst building will be located, the habitat is of course urban in the extreme: there is no "natural" environment *per se*. Here too, however, the goal remains to integrate the structure as much as possible with the surrounding area. Fox & Fowle, the architects for the Durst Organization and a member of the Green Development Collaborative, have done this by designing two quite different facades – a relatively corporate one facing 42nd Street, and a much more whimsical one facing Times Square. At UNEP's office, site planning is not a factor because it is only the interior offices that are being renovated.

Another important consideration is managing the construction process itself. Care must be taken to protect the site, construction workers, neighbours and employees. The UNEP office in New York offers a special challenge because the space will not be vacated during renovation. While a certain amount of disruption is inevitable, debris, dust and distraction must be kept to a minimum so UNEP employees can be protected from construction-related contaminants and come as close as possible to conducting business as usual.

Materials selection

Traditionally, designers choose what materials to use based on such factors as cost, aesthetics, availability, ease of installation, durability, and maintenance requirements. Sustainable design calls for the impacts on environmental and human health to be a paramount consideration as well. What are the cradle-to-grave life cycle impacts of the material and its various components? Does it have recycled content and, if so, how much? Is it recyclable or, better yet, reusable? Does it use or release toxic or hazardous materials such as formaldehyde? There is a long list of such questions sustainable designers must ask. At the UNEP offices, the answers are translating into the use of non-toxic paints, non-flaking ceiling tiles, and recycled carpeting, to name just a few of the many green products that will be used.

Ergonomics is another important factor. One of the goals of sustainable design is productivity. So to the extent that, say, an uncomfortable chair or a keyboard that encourages carpal tunnel syndrome reduces productivity, they are in that sense unsustainable. At the UNEP site, the special Task Force will recommend what office furniture and equipment to use.

Maintenance is another important and easily overlooked consideration, "If you build green and don't maintain green, you end up brown," says Asher Derman. At the UNEP site, the Task Force will recommend that the offices are maintained using non-toxic cleaning products and vacuum cleaners equipped with microstatic filters that keep dust and other particles from being released into the air.

Energy planning

Although today's office buildings are much more energy-efficient than those of 20 years ago, much progress is still to be made. The technologies and know-how are largely available: what remains is the largely communications challenge of persuading builders that energy efficiency makes good business sense. Sustainability advocates have many weapons at their disposal. In one documented case study after another, the payback period for up front investments in energy-efficient technologies is three years or less. Despite this impressive ROI, however, energy efficiency remains a surprisingly difficult sell because many investors have a knee-jerk resistance to higher up front costs.

At the UNEP site, the possibilities are limited because the building's energy infrastructure cannot be altered. But some steps can be taken. Planned measures include sensors that turn off the lights when no one is present, and the installation of ultra-violet filters for the windows. At 4 Times Square, according to Robert F. Fox, Jr. of Fox & Fowle, "Gas-fired chillers rather than electric-fired ones will be used. Although more expensive up front, this will save millions of dollars in energy expenditures over time. In addition, a combination of steel and concrete is being used for the infrastructure, instead of all steel. This reduces overall 'cradle-to-grave' levels of energy consumption because it takes less energy to manufacture concrete than to fabricate steel."

Waste management

Another principle of sustainable design is the minimization of waste, both during construction and post-completion. "A building is like a living organism," says SITE II's Josh Weinstein. "It takes in energy and produces waste." Using building materials that are properly sized is one way to reduce waste. Another is to use materials with recycled content that are themselves recyclable or reusable. A third waste management option is cogeneration, a technique that converts what would otherwise be wasted energy into steam for use as additional energy to heat the building.

Yet another issue involves managing the garbage produced by tenants. The Durst building at 4 Times Square will feature separate waste disposal chutes for bottles, paper, and wet garbage.

Air quality

Inadequate indoor air quality is a pervasive problem. As noted earlier, it exists in many buildings around the world. Although numerous case studies have been compiled, the impacts of poor indoor air quality have not yet been conclusively quantified. It is intuitively obvious, however, that it reduces employee productivity. Thus it is critically important to tackle this issue for business as well as quality-of-life reasons.

There are three basic strategies for addressing the problem: assuring an adequate flow of air, reducing or eliminating the release of microbes and other harmful substances through the ventilation system, and using products that do not release noxious gases into the atmosphere. At the UNEP offices, the ventilation system cannot be redesigned, but HEPA-grade (HEPA stands for High-Efficiency Particluate Air) filters can be installed that trap minuscule particles. In addition, the Task Force will minimize the use of products that offgas volatile organic compounds (VOCs). The building at 4 Times Square will conform to the American Society of Heating, Refrigeration and Air-conditioning Engineers' guideline requirement ASHRAE 62-1989, which sets a standard for indoor air quality that substantially surpasses local ventilation code requirements.

Design for flexibility

Finally – and to some extent this principle flows from the other five – buildings must be designed for maximum flexibility. The "churn rate" in commercial offices is high. Office space is used for one purpose for several years, then taken over by a new tenant for a different use, and then by still another tenant several years later. These regular renovations need to be undertaken in as resource-efficient a manner as possible. Moreover, after many years of use for one purpose, some buildings are reconceptualized for an entirely different purpose: the crop of military bases currently being decommissioned provides a stellar example. It is generally more eco-efficient to renovate than to rebuild, making it important in the initial design to plan for this long-term possibility.

Critical issues and challenges

Sustainable design presents a unique set of challenges. The first involves the need for ongoing oversight on the part of the design team. In practice, architects tend to disengage somewhat from the project once the design phase has been completed. This is not necessarily a good idea, and it is particularly problematic where sustainability is a central design theme. At Healthy Properties and the Green Development Collaborative, we are continually integrating multi-disciplinary strategies, which calls for continuing active involvement by the design team. This is true where the design aesthetic mandates the seamless integration of the building into the natural environs, and also where the required oversight is more technical than aesthetic.

SU[illegible]ND ASSOCIATES/FOX & FOWLE ARCHITECTS, PC

4 Times Square, view from Bryant Park

A second set of issues concerns partnership and collaboration. All significant building projects require a broad range of skills and are necessarily collaborative in nature. However, building for sustainability can make the delicate art of collaboration even more subtle and complex than usual. One reason for this is that sustainable buildings are highly desirable from a public policy perspective, which often brings a new partner, the public sector, actively into the mix.

A third issue involves costs. The good news is that the up front expense of building for sustainability is declining, due largely to two factors. First, the cost of environmentally friendly building materials is lowering as a result of the entrance of large manufacturers into the marketplace. Second, builders are finding they can offset some of the additional costs. For example, more energy-efficient window glazing and insulation strategies can make it possible to downsize heating and cooling equipment by 50 per cent or more. While costs do tend to be higher, this greater up front investment can usually be recouped within a few years through increased energy savings. In addition, at Healthy Properties and the Green Development Collaborative we are persuaded that due to pent-up demand and short supply, green buildings will prove to be more valuable, command higher rents, and lease up faster.

Another issue is philosophical. To what extent should a building's green character be in plain view? There are two schools of thought. One proposes that all a building needs to do is perform green through greater energy efficiency, the use of sustainable products and materials, and so on. The other takes a broader view of architecture and argues that buildings are educational as well as functional and should therefore deliver a clear visual message about the need for environmental sensitivity. James Wines of SITE Environmental Design has designed a number of striking buildings that provide strong iconographic evidence of their green commitment and aesthetic.

Lastly, there is the theme with which I began this article - the need to persuade mainstream commercial builders that going green makes good business sense. A plausible case can be made that this is in fact so. According to Ken Levien, president of Levien & Co., a project management firm and a member of the Green Development Collaborative, "In New York City, the average total cost of an office worker is about $40,000, and the average space that is occupied per worker is about 200 square feet, making the employer's cost for space about $200 per square foot per person. If sustainable building features increase productivity by 10 per cent, that translates into an additional rental value of $20 per square foot. This creates a substantial benefit for tenants and owners alike."

This, then, is the logic; but the challenge remains to pin the numbers down. The 10 per cent figure cited as a productivity increase is supported by a number of published cases, but as yet there has been no definitive study that conclusively quantifies the extent to which sustainable features increase productivity. "Many green issues can be defined in terms of payback," says Barry Donaldson, Executive Vice President of Tishman Research Corp., a subsidiary of Tishman Realty & Construction. "However, many of the variables are soft. We know intuitively, for instance, that natural daylight increases productivity. But it is difficult to quantify."

Business cases are built on hard numbers. If the productivity gains through sustainable building can be persuasively quantified, the argument for building (and renting) environmentally sensitive buildings will be that much more compelling.

Conclusion

All around us the evidence points incontrovertibly to the same conclusion: we are leaving the industrial age and entering the age of ecology. This is neither hypothetical nor a matter of aesthetics. It is a social, economic and environmental reality. Unfortunately, the mainstream building industry has hardly begun to grasp this fact, and so it falls upon forward-thinking members of the building community to help awaken the industry from its slumber.

To do so, two parallel strategies must be followed. One focuses on peoples' minds and is called education; the other focuses on the material environment and manifests itself in the form of sustainable offices and buildings. At Healthy Properties, L.L.C. and its Green Development Collaborative, we are walking both paths simultaneously. We need and invite other members of the building community to do the same.

Barry H. Dimson is the president of Healthy Properties, L.L.C., and chairperson of the Green Development Collaborative. This article was written with the research and editorial support of Carl Frankel, J.D., president of The Bridge Group, a sustainable-development consultancy.

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The US Environmental Protection Agency's Energy Star buildings programme: energy saving in commercial buildings

The energy consumed for the running of buildings in the United States costs about US$ 70 billion per year. In addition to being costly, the production of this energy, mostly electrical, contributes to a range of environmental problems: global warming, acid rain, smog, etc. The voluntary energy-efficiency programme, Energy Star, launched by the US Environmental Protection Agency (EPA) in 1994, helps owners and users of commercial buildings make energy savings in key areas. A typical office building consumes energy in four main areas: lighting systems (29 per cent); air-handling systems (28 per cent); cooling systems (24 per cent); and office equipment, elevators, auxiliary heating and other systems (19 per cent). The five-stage Energy Star programme helps plan energy-efficiency upgrades in each of these areas. The participating companies, known as "Partners", are asked to perform the upgrades only when it is profitable for them to do so, in order to maximize savings while minimizing energy use. When companies are ready to implement their upgrades, the EPA provides unbiased information and advice about building systems and equipment interactions, to allow partners to make better-informed decisions.

Stage 1. The first step partners are required to take is to sign up to the voluntary "Green Lights" programme, under which they agree to implement energy-efficient upgrades of their lighting equipment within five years. Joining Green Lights is a prior condition for acceptance as a partner in the rest of the Energy Star programme.

Stage 2. The partners and EPA develop a preventive maintenance plan, checking and adjusting building systems.

Stage 3. Heating, ventilation and air conditioning (HVAC) loads are reduced by installing window films and reflective roof coverings, and by installing more effective roof insulation. This stage also involves switching to energy-efficient computers, monitors and printers.

Stage 4. Fan systems are upgraded and equipment size is reduced; existing motors are replaced with smaller, high-efficiency models; and variable air volume systems are fitted with variable speed drives.

Stage 5. Chillers are upgraded or replaced to implement programmes for phasing out of CFCs. This requires retrofit of water pumps and compressors with variable speed drives. Electrical resistance heat technology is replaced wherever possible.

This step by step approach allows Energy Star partners to obtain affordable energy savings of between 30 and 40 per cent.

For more information, contact: The Manager, Energy Star/Green Lights, US EPA (6202J), Washington, D.C. 20460, USA. Tel: +1 (202) 775 6650.

Public/private strategies for moving towards green building practices

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Abstract

Improving energy and environmental performance in the building industry requires action on a broad front, involving a combination of mandatory and voluntary measures developed in consultation with industry associations and other relevant parties. Some Canadian initiatives of the past ten years are described, many of which might also be applicable in other countries. Means still need to be found to stimulate the private sector to design buildings to higher levels of performance and ensure that these levels are achieved and maintained.

Résumé

Optimiser l'utilisation de l'énergie et le respect de l'environnement dans le domaine de la construction nécessite de mener une action sur de nombreux plans, mêlant mesures obligatoires et volontaires élaborées en concertation avec les associations professionnelles et les autres parties concernées. Des initiatives canadiennes de ces dix dernières années sont décrites ici, dont un grand nombre pourraient être appliquées dans d'autres pays. Reste à trouver les moyens d'encourager le secteur privé à mettre en oeuvre cette optimisation dans son travail de conception et à faire en sorte qu'elle se traduise dans les faits et perdure.

Resumen

Mejorar la prestación energética y medioambiental en las industrias de la construcción requiere acción en un frente bastante amplio, que implica una combinación de medidas obligatorias y voluntarias desarrolladas en conjunto con asociaciones industriales y otras entidades concernidas. En este artículo se describen algunas iniciativas canadienses de los últimos diez años, muchas de las cuales se pueden aplicar en otros países. Obviamente, todavía se necesita encontrar medios para motivar al sector privado para que realice diseños con mejores niveles de prestación medioambiental y para que garantice que estos niveles se alcancen y se mantengan.

Most national governments are concerned with the energy and environmental performance of their building stocks, but it is an issue of special concern for many developing countries, especially those with high rates of economic growth. In such regions it is common to see very ambitious construction programmes taking place, with rapid construction and low cost taking priority over high performance. Such development efforts also involve the construction of large numbers of new building types, for example office buildings, which are by their very nature more energy-intensive than other building types such as housing. But the housing sector has new energy problems, too: in Shanghai and Hong Kong, for example, it is easy to see the proliferation of air conditioners and other energy-consuming consumer goods which are becoming rapidly affordable and which indicate energy troubles ahead.

In my view, there is considerable potential for minimizing the potential damage to the environment if resolute steps are taken immediately, so that the pattern of further construction can be skewed in a positive direction before building industries become used to bad practices. Such policies can also have a beneficial impact on the whole building industry in such regions, by making their products more attractive in the export market.

Canada is trying to come to grips with the problem of excessive energy use and harmful environmental impacts. Our efforts cannot be said to be totally successful, but we are approaching a stage where the nature of the problem can be seen clearly and where a description of these efforts may be useful to others.

The Canadian context

Most activity in the Canadian building sector is led by private firms who follow market forces, and the market does not always point in the same direction as long-term public policy. In our experience, any change in the building sector is therefore only effective if a combination of mandatory and voluntary measures are used. In recent years, even mandatory measures have been found to be much more effectively implemented if industry associations and the private sector are involved in the development of such measures. Another reason for a cooperative approach is that Canada's building sector is a complex one, consisting of a few large companies and industry associations plus many small companies and associations. In such an organizational environment, achieving coordinated action requires close collaboration between all parties.

Nevertheless, governments can play a strong role. They can establish codes and regulations that provide mandatory levels of performance for everyone in the industry. They can also support the development of non-mandatory product and equipment standards or performance guidelines, which can influence the market. A third route, not often used today because of the cost implications, is to provide financial incentives for high performance.

Another way for governments to influence events is to lead by example. Governments own or lease a large number of buildings (the government of Canada occupies in excess of 50,000), and the public might be be justified in expecting that governments should put their own houses in order before telling others to do so.

In summary, improving performance in the building sector requires action on a broad front. To be successful, governments must develop alliances with all powerful groups in the industry, ranging from provincial governments, power utilities and industry associations to individual companies. The large number of organizations involved and the vast scale of the problem means that the job is analogous to trying to change the direction of a very large ocean liner with a fleet of tug-boats, some of which are pushing in opposite directions.

A partial overview of the Canadian experience

The remainder of this short article will be devoted to describing some Canadian initiatives implemented over the past ten years. The initiatives described are some of the ones I am most familiar with relating to energy efficiency and environmental impact in the large-building sector. They exclude some important national and provincial measures dealing with the control of soil pollution and impact on natural ecosystems. Although some of the initiatives described are uniquely suited to the Canadian situation, many of the principles followed are applicable to other jurisdictions.

The National Energy Code for Buildings (NECB)

Canada is completing the development of a national energy code that will establish minimum performance requirements for both small houses and larger buildings. The absence of such a code has made it difficult in the past to achieve high performance except through expensive subsidies.

The Code has been largely carried out by Canada's National Research Council, working in close collaboration with industry representatives. It should be noted that in Canada, although national authorities may propose a building-related code, it must be approved and adopted by provinces or other local jurisdictions to have the force of law. The NECB is now being completed and will be available as a "model code" by the summer of 1996, after which it is expected to be adopted by other jurisdictions over the next three years. The NECB is unique in the world in its combination of alternatives offered to the designer, the inclusion of climatic variables, and in its emphasis on the regional cost-effectiveness of measures. The structure of the NECB is probably applicable to many other regions.

The Energy Efficiency Act

The minimum energy performance requirements required by the national energy codes for buildings and houses have been complemented by a series of regulations relating to building equipment and systems. These have been established under the authority of the Energy Efficiency Act, passed in 1993. The Act covers three main areas, most of which relate to residential uses, large and small:

1. the minimum energy performance of energy-using products, doors and windows;
2. the energy labelling of energy-using products; and
3. the collection of statistics and information on energy use and alternative energy.

Of chief interest to our topic are the regulations that cover energy-using products that account for about 60 per cent of residential energy demand. These include major residential appliances, heating, cooling and ventilation equipment, water-heating equipment, and other energy-using equipment such as lights and electric motors. One component of the regulations is the *EnerGuide Programme*, a system of labelling residential household equipment that gives consumers a means of comparing the energy consumption of each model of a product. The strategy is to encourage consumers to buy the most energy-efficient product in its class, even if this exceeds the minimum required energy performance.

The Environmental Choice Programme

This programme was initiated by the federal government, but has now been spun off into the private sector. It identifies materials, products and services that are considered to minimize adverse impacts on the natural environment. Those approved are awarded a label, called "EcoLogo". The programme is not mandatory, and the strategy is to influence the purchasing decisions of professionals and consumers.

Federal Buildings Initiative (FBI)

The FBI programme is designed to improve the energy performance of about 50,000 buildings (mainly office buildings) owned by the Federal Government. Because of the current budgetary problems of the Canadian governments, the programme has been structured to reach its goals with little or no capital cost to the government. This has been achieved by transferring a private sector idea into the public sector: performance contracting. The system operates by having private sector firms design the energy improvements, install them, pay for the work, and train the owners' staff to operate the new systems. The private firm is repaid for the work out of the energy savings, i.e. the difference between the original energy operating costs and the new and lower costs. The programme has been applied to some 2500 buildings so far, representing a private sector investment of some $200 million and an operating saving of about $25 million per year.

C-2000 Programme for Advanced Commercial Buildings

The C-2000 Programme is a small demonstration programme for office or multi-unit residential buildings that conform to a set of very demanding performance requirements. The idea behind the programme is to transfer ideas about design or the use of certain technologies to the industry. This could be done by providing financial subsidies, but such an approach would be too expensive considering the high cost of large buildings. The strategy in this case is to demonstrate to the industry that a small number of buildings can reach the performance targets without excessive costs or difficulty.

The programme is sponsored by Canada's energy ministry, whose objectives are concentrated in the area of energy and the environment. The energy performance target is very ambitious: energy consumption in C-2000 buildings is to be no more than 50 per cent of that of conventional buildings. Despite this, the performance requirements of the programme are designed to be as holistic as possible, on the assumption that a focus on only energy and envirornmental measures will not convince the industry to take up the performance standard. Thus, performance requirements have been established for energy consumption, environmental impact, indoor health and comfort, adaptability to new requirements, and ease of maintenance. It should be noted that C-2000 developers are also required to design leases that encourage responsible behaviour on the part of tenants.

Interim results indicate that this broad strategy is working, and that the handful of buildings designed under the programme are meeting the performance requirements at lower-than-expected capital cost increments. This success is largely attributed to the clear design guidelines that have been developed and the process requirements, which place a strong emphasis on the close cooperation of inter disciplinary teams.

Work is now proceeding on the development of a second-generation set of design guidelines, which will be widely distributed to the industry.

Building Environmental Performance Assessment Criteria (BEPAC)

The BEPAC initiative is a system to assess the energy and environmental performance of new and existing office buildings. BEPAC was developed by a group of Vancouver academics and industry experts. It is now being applied to government office buildings in the province of Ontario. The BEPAC system is promoted by a non-profit organization, the BEPAC Foundation.

BEPAC is one of two internationally recognized systems of its type, but neither system should be confused with energy audit systems, which are considerably narrower in scope. The significance of the BEPAC initiative is that, if the system is promoted and broadly accepted as a performance benchmark, public and private sector tenants who want to select superior accommodation will have the tool to do so, which can be a very powerful inducement to developers to raise their own standards of performance. To date, the BEPAC assessment method has only been developed for office buildings.

Remaining problems

A major issue not fully addressed in the programmes above is the need to ensure that buildings actually reach the performance levels they are designed for, and that performance is maintained over the long term. A wonderful design can be rendered quite irrelevant if construction quality is so poor that the wind can whistle through the walls or ventilation fans are installed backwards. Such things actually happen. Even if well constructed, the performance of a large building can vary substantially according to the skills and training of the building operators. The need to *commission* buildings (to ensure that systems operate as designed) and the need to maintain skilled operators and maintenance people are respected more in theory than in practice in Canada.

It must also be admitted that the initiatives taken to date are insufficient to raise performance levels to the extent that will be needed to reach Canada's commitment to reduce CO_2 emissions. After all, standards set by a code (as in the NECB) are meant to establish a *minimum*, and therefore cannot be set too high. The FBI programme and its provincial equivalents deal only with public sector buildings. A problem with voluntary or incentive programmes, such as BEPAC, C-2000 or EcoLogo, is that the developers and owners of commercial buildings are mainly concerned with the economic return on their investments. With energy prices relatively low, and environmental measures lacking a financial payback, the takeup of such programmes is bound to be somewhat limited. More initiatives are therefore needed to convince the private sector to go beyond the minima.

How, then, to influence the private sector to design buildings to a higher level of performance and ensure that they meet and maintain such levels?

Tax measures

One approach that has not yet been tried is to make tax benefits available to owners of buildings which continue to meet a minimum energy and environmental performance target that is established by an independent agency. Such a scheme would have to involve annual inspections and reviews of operating records. If such an approach resulted in a net outflow of tax revenue, it would be met with a marked lack of enthusiasm by the financial agencies in most governments including Canada's. However, small adjustments could be made to slightly *reduce* the tax burden for high performance buildings and to slightly *increase* it for standard buildings. Since very few buildings would meet the required performance targets at the beginning of such a programme, the short-term result would be a *gain* in revenues for governments.

Building labelling

Building labelling is another approach with much potential. The concept of labelling is used to differentiate between performance levels of various products. It has been successfully applied to home appliances (e.g. the EnerGuide system) and, in some jurisdictions, to the overall energy performance of houses. The concept is being applied to larger buildings in the UK through the Building Research Establishment Environmental Assessment Method (BREEAM), which is being used in voluntary assessments of some 15 to 20 per cent of new office buildings.

A labelling approach has the potential of causing major improvements in the way large buildings are designed and operated, if the market (real estate brokers, tenants) accepts it as a tool to help make occupancy decisions. In our experience, private sector developers will rapidly change their way of designing buildings if they perceive a market demand to do so. From a public policy perspective, labelling offers an excellent way of improving the energy and environmental performance of the building stock, as long as it is recognized that the criteria must include a broad range of market-oriented performance parameters that will be accepted by the market. The implementation of such a system must be led by industry associations or private sector organizations to ensure widespread penetration, although system development will require public funding. Efforts are now taking place in Canada to develop a version of the Canadian BEPAC system suited to a large-scale building labelling programme.

Information

All of the initiatives described in this article are useless unless those who make decisions become aware of their potential. Developers, building owners and designers usually inform themselves about legal requirements such as codes and regulations, but many remain ignorant of information about technical developments or voluntary programmes. In order to ensure that information is more freely available, a non-profit organization called the *Green Building Information Council* (GBIC) has been founded to focus on the information problem. This organization is intended to act as a bridge between governments and the private sector, and it aims to change the industry's attitude about the environment. GBIC focuses its activities on local meetings, a publication called *Advanced Buildings Newsletter*, and an Internet site that carries extensive information about new initiatives. Our Internet address is *http://greenbuilding.ca*, and we look forward to establishing more international links.

Nils Larsson is Programme Manager for CANMET's C-2000 Programme for Advanced Commercial Buildings, which has resulted in the design and construction of several state-of-the-art commercial buildings across Canada. He is a founding member of the Green Building Information Council and is founder and editor of the Advanced Buildings Newsletter.

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Bridging the globe: creating an international climate of engineering and construction innovation

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Abstract

This article addresses the obstacles facing the engineering and construction industry in the United States and the solutions being implemented to counter them. Engineering and construction professionals are working together to generate innovative approaches and technologies. Specific examples are given of how these partnerships are bringing about a change in the way the industry operates. The International Research Symposium, recently hosted by CERF in Washington, D.C. culminated in the development of a "global research agenda" composed of 38 specific research proposals aimed at helping to increase awareness of sustainable development in the international engineering and construction community.

Résumé

Cet article traite des obstacles auxquels se heurtent les métiers de l'ingénierie et du bâtiment américain, ainsi que des solutions mises en oeuvre pour les surmonter. Des professionnels de ces secteurs travaillent conjointement à l'élaboration d'approches et de technologies novatrices. Des exemples précis montrent comment ces partenariats changent le mode de fonctionnement de ces secteurs d'activité. L'International Research Symposium, qui s'est tenu récemment à Washington D.C. sous l'égide du CERF, a abouti à la rédaction d'un « ordre du jour de la recherche mondiale » fort de 38 propositions de recherches spécifiques visant à sensibiliser plus avant ces métiers au développement durable.

Resumen

Este artículo esboza los obstáculos que deben enfrentar la industria de la ingeniería y la construcción en los Estados Unidos y las soluciones que se adoptan para contrarrestarlos. Los profesionales de la ingeniería y la construcción trabajan conjuntamente para generar enfoques y tecnologías innovadoras. También se incluyen ejemplos específicos sobre cómo estas asociaciones realizan un cambio en la forma en que funciona la industria. El Simposio de Investigación Internacional realizado recientemente por CERF en Washington, D.C. culminó con el desarrollo de una "agenda de investigación mundial" compuesta por 38 proposiciones de investigación específicas cuyo propósito es ayudar a aumentar la conciencia sobre el desarrollo sostenible en la comunidad internacional de ingeniería y construcción.

Throughout the world the engineers and constructors of the built environment – the planners, architects, engineers, constructors, regulators, facility managers and others who design and build facilities – shape the way the world population uses the physical infrastructure to live, travel, work and play. As the economies of the world continue to expand, these engineering and construction professionals are faced with the challenge of developing the infrastructure in a way that will protect and conserve environmental quality and natural resources. Future development undertaken in a sustainable manner represents a new way of thinking in planning, designing, building, operating and maintaining the built environment.

To realize the goal of a sustainable future, the engineering and construction industry must overcome many barriers today. Consider the current condition of the construction industry in the United States: most infrastructure is designed based on first cost rather than life cycle costs; consensus is lacking on government design and construction policies; architecturally influenced choice is often limited by the knowledge base used to approve plans and to construct the facility; and the US construction industry lacks standardization and uniform practices for evaluating innovative technologies, materials and systems.

Partnerships are providing solutions

The engineering and construction industry is finding that the growing demand for sustainable construction is resulting in some remarkable changes in the way the industry can do business. In the US and in other countries, unique challenges are confronting designers and builders on construction sites now as never before. Whether it is deciding how to renovate and reuse an existing structure, or how to incorporate renewal design in all facets of facility construction, renovation, rehabilitation, or ultimate demolition or disposal, these challenges demand unique solutions. Stakeholders in the engineering and construction community are therefore turning to one another to generate in partnership the innovative approaches and technologies that will take them into the next century.

For instance, the Southern California Gas Company recently recycled its 38-year-old facility to create a state-of-the-art Energy Resource Center. One-third of the existing building was demolished, the remainder gutted, and a two-storey central structure added.

In addition, the company pursued an aggressive course of recycling. Sixty per cent of the 550 tonnes of building material removed from the existing building was reused or recycled. Eighty per cent of the new building's construction materials, interior furnishings, and displays are either recycled or contain recycled materials. For instance, weapons confiscated by Los Angeles County were melted down to make reinforcing bars; recycled aircraft aluminium was reused as an accent wall; and ground-up plastic pipe was used as a concrete admixture. By choosing to recycle rather than rebuild, Southern California Gas Company saved $3.2 million in land costs and utility infrastructure. And the building uses one-third less electricity than conventional buildings of the same size.

Another such partnership was generated when the central post office in Reno, Nevada, a modern, noisy warehouse building with high ceilings and black floors, needed to be renovated. The facility was selected to receive a minimum energy user renovation, the cost of which was approximately $300,000. Several features of the renovation made a positive impact on the end user: a lower ceiling made heating and cooling easier and more affordable and created better acoustics and lighting of working areas was enhanced by sloping the lower ceiling, which made possible the indirect lighting of working surfaces and replaced harsh direct lighting.

The following additional benefits accrued from these modest, innovative renovations: energy and maintenance savings added up to $50,000 annually, or a payback on the cost of the renovation in six years; productivity increased about 6 per cent; and the rate of sorting errors by machine operators decreased. These productivity gains are worth $400,000 to $500,000, or a payback for the entire renovation in less than a year.

The US Army Corps of Engineers also has an interest in sustainable design. The Army's Construction Engineering Research Laboratories have developed a plan for a sustainable (or green) neighbourhood on the army base at Fort Hood, Texas. This project features a multidisciplinary, collaborative design team approach which includes architects, engineers, landscape architects, urban planners and residents (including children). The cluster type residences minimize land use, augment energy efficiency, and maximize layout. They are site-specific and modular in design and construction techniques and employ envelope fenestration, which provides natural ventilation, improved indoor air quality, and increased insulation.

The benefits of the green neighbourhood concept are an improvement in the quality of life for military personnel which positively affects family satisfaction, soldier retention, and safety; reduced life cycle costs and increased efficiency of maintenance, city services, and energy and water consumption; and reduced negative environmental impact through curbing of sprawl, integration of natural elements, careful selection of materials, and consideration of the embodied energy-recycled content of materials and systems.

There is also a movement afoot in private industry, bringing together stakeholders in the engineering and construction community. In Portland, Oregon, the Oregon Arena Corporation (OAC) joined forces with its general contracting company, Drake/Turner, to devise an aggressive recycling strategy on a construction project. Drake/Turner contracted with an environmental consulting firm to develop a construction waste management plan. When the plan was complete, local haulers were invited to bid on the job of implementing it. A local minority-owned company and another waste management company won the contract. They were to be responsible for collecting the trash at the site and collecting the recycling bins, respectively.

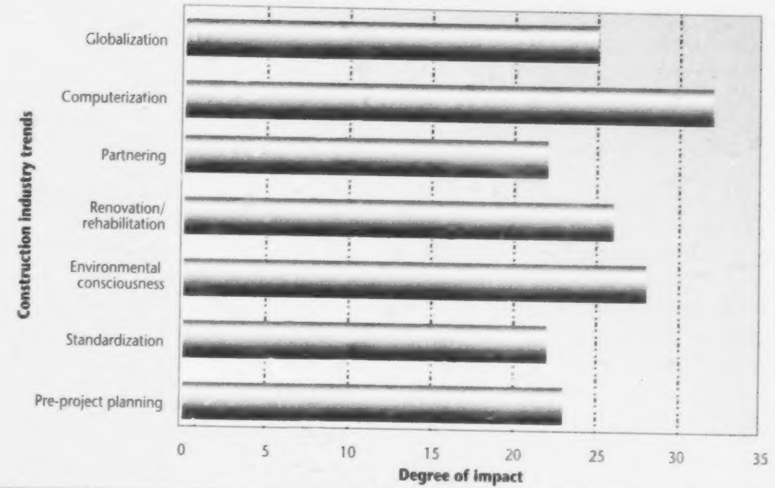
When the plan was fully implemented, only 2 per cent of the total waste generated went to landfill. The remaining waste was recycled by local facilities or used for fill at several local sites. A preliminary cost-benefit analysis indicates that the project has realized $81,000 in savings to date from recycling of metal, wood and cardboard alone.

Setting a global research agenda

The "International Research Symposium: Engineering and Construction for Sustainable Development for the Twenty-First Century," by the Board of Directors and Corporate Advisory Board of the Civil Engineering Research Foundation (CERF), was held in February of this year in Washington, D.C. More than 700 delegates from over thirty countries attended the symposium, to work in collaboration to establish a global research agenda focusing on issues related to buildings and infrastructure in a sustainable environment.

CERF, which was created in 1989 by the American Society of Civil Engineers (ASCE) as the facilitator, coordinator and integrator of research for the civil engineering profession and the design and construction industry, organized this symposium as part of its mission to serve as an industry-guided and industry-directed research organization to enhance the quality, timeliness, and effective delivery of essential research and innovation, while ensuring coordinated efforts and activities among institutions with similar agendas. One of the purposes of CERF's symposium was to make the kinds of partnerships mentioned above more widespread, and even to create an international engineering and construction climate that would embrace the generation of such collaborative partnerships on a global scale. It is anticipated that these partnerships will accelerate innovation by the application of research in the international engineering and construction industry. The symposium is part of a continuing evolutionary activity designed by CERF to ensure that innovative ideas and research are moved efficiently into practice.

Figure 1
Results of the Delphi Survey
Key industry trends



The Delphi survey

The case studies mentioned above are indicative of a trend noted in 1994 by respondents to a Delphi survey conducted by CERF in preparation for the symposium. **Figure 1** shows the key industry trends identified by the more than 1500 design and construction industry practitioners, academics and government officials throughout the world who were asked to describe their views on issues confronting the engineering and construction industry. The findings from the survey validated the need for industry to adapt to the challenges of providing for basic human health and comfort requirements while availing itself of economic opportunities through environmentally sustainable development.

The survey results defined issues facing the industry in the areas of management and business practices, design technologies and practices, construction and equipment, materials and systems, and public and government policy. The leaders from more than 30 countries used the materials furnished before the start of the conference to forge international collaborative partnerships to carry out a common agenda of new and needed proposals to guide the engineering and construction communities into the 21st century.

Setting a sustainable construction research agenda

The symposium culminated in the development of a global research agenda encompassing 38 specific research proposals, called "prospectuses". These prospectuses are aimed at helping create a global sensitivity to sustainable development in the design and construction industry. They exist for the five areas briefly described below.

Management and Business Practices

The prospectuses supporting the area of Management and Business Practices recognize that an effective management process is a key ingredient in providing the design and construction services needed for sustainable development in the 21st century. Producing sustainable projects requires not only new approaches to management, but also effective communication and education programmes and the use of innovative technologies.

Management covers a wide spectrum of topical matters. A key requirement is that management provide vision and leadership for the entire industry. This means it must first help define the problem, which will not occur if managers in business, professional practice, research or educational institutions deal with this challenge as a static condition. All managers, throughout the industry, must deal with the dynamic changes taking place, learn from past and current trends, and focus on future solutions that will improve the process of design and construction while protecting the state of our natural heritage. As might be expected, the Management and Business Practices area places a heavy emphasis on the need to streamline the construction process in terms of clarifying roles, responsibilities and risks in all phases of the process.

Design Technology and Practices

The prospectuses in the Design Technology and Practices area reflect four themes: designing for sustainability, globalizing design practice, new tools and technology, and education and training. These themes encompass the challenges facing designers seeking to achieve design goals and to lead the engineering and construction community towards achieving sustainable development in the 21st century.

Design is the process of identifying and solving problems having to do with the form, use and management of facilities and communities, infrastructures, and other elements of our built environment. Design encompasses a range of activities that precede construction or other changes in the built environment. The outcome of design inevitably depends on the context in which the process is conducted, the resources available for both design and subsequent actions, the people involved, and the ways they perceive and represent problems and solutions.

The process and outcomes of design are central to achieving sustainable development. Private and public sector entities act on designers' recommendations to change and use the built environment. The procedures, methods and tools they use shape the ways designers perceive problems and solutions and affect their productivity, accuracy, and efficiency.

Construction and Equipment

The prospectuses in the Construction and Equipment area emphasize the development and use of innovative technologies to improve the productivity and operating efficiency of the construction industry. These prospectuses further recognize that improved construction and equipment technologies and practices are needed to meet the goals of engineering and construction for sustainable development in the 21st century. Improved construction and equipment will safely clean up hazardous sites, protect the safety of workers and increase their productivity, improve the quality of the constructed facility, and reduce the time required to bring facilities into service.

In the Construction and Equipment area there are many opportunities to utilize innovative technologies, not only in construction but also in the delivery of engineering and construction services. The area also addresses the reality that the industry faces many unique barriers that slow the delivery of beneficial new technologies at the rate needed to realize their potential benefits. These barriers include industry fragmentation, risk aversion, compartmentalization, single contract risk/reward imbalance, expectations to recover investment on single projects, and difficulty in estimating benefits.

Materials and Systems

The prospectuses in the Materials and Systems area acknowledge that the construction industry faces a major challenge in developing contemporary building solutions that will support and be conscious of improving the global quality of life. The industry must not only develop high-performance materials and systems, but must also promote global action plans to expedite their application. This strategy requires the adoption of life cycle cost minimization principles which include environmental impacts, since new materials and systems that facilitate design durability, ease of construction, demolition and reuse directly benefit the life cycle characteristics of the built environment worldwide.

In the Materials and Systems area it is recognized that repairing, rebuilding or expanding infrastructure with today's conventional systems and materials will produce structures destined for premature obsolescence. The availability of high-performance materials alone does not guarantee systems appropriate to enhanced sustainability. Maintaining such basic support systems will burden both industrialized and developing nations if they are not designed to minimize overall life cycle costs, including financial requirements and environmental impacts.

Public and Government Policy

The prospectuses in the Public and Government Policy area concentrate on three interrelated government policy topics: (1) the role of engineering and construction officials in sustainable development, (2) public-private mechanisms to meet performance and sustainability goals, and (3) promotion of innovation. Industry leaders believe the ability of the construction industry to realize long-lasting and large-scale change will be limited without concomitant change in public and government policy. The three policy topics are seen as underpinning the symposium's goals and vision. This effort must include not only the construction industry members, who by their actions can influence policy, but those who will use the recommendations to shape public and government policy. Members of this target audience exert enormous influence on project funding as well as the enactment of laws and regulations. Within this context, the construction industry profession has a critical role to play in enabling needed public and government policy reform.

Next steps

Generating this global research agenda was a major collaborative effort. It was singularly successful because of the talents and zeal of the industry practitioners, government leaders, and members of the academic community who took part. But even more crucial now is putting these good ideas into action. The global research agenda laid out here in brief provides a framework for action, directed towards improving building practices worldwide.

To effect these changes, the international construction and engineering community must take action, clear away obstacles in order to realize the ability to make change, provide a framework to bring the recommendations into realization, and encourage stronger partnerships.

To make this transition easier, CERF is calling for new partners to join those that have already signed on and begun working to take ownership of the projects called for in the prospectuses. These organizations and individuals will continue to lead and participate in the establishment of the collaborative programmes necessary to address the objectives of the individual prospectuses. The partners in this endeavour will have the opportunity to work together on the cutting edge of the industry, at the same time developing, promoting and enjoying the benefits of innovation. By participating, partners will be able to take advantage of the newest design and construction technologies and techniques. It is time to take the next step now.

Harvey M. Bernstein is the President and Chief Executive Officer of the Civil Engineering Research Foundation (CERF). CERF integrates diverse groups within the civil engineering community to facilitate, coordinate and integrate common solutions to complex research challenges facing the civil engineering profession. Mr Bernstein created and chairs the National Council for Civil Engineering Research (NCCER), which provides an opportunity for more than 100 research-related national associations and government agencies to work together toward common goals. In addition, he serves on the US National Preparatory Committee (NPC) for Habitat II. He is the co-author of the recent book, Solving the Innovation Puzzle: Challenges Facing the Design and Construction Industry. ◆

Life cycle embodied energy and carbon dioxide emissions in buildings

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Abstract
There is considerable information available concerning the energy used in buildings, but until recently little attention was paid to the energy used to produce and transport building products. This energy, often called "embodied energy", is of growing importance in the context of assessment of environmental impacts and the fight to reduce greenhouse gas emissions. This article discusses techniques for calculating embodied energy and considers its strengths and weaknesses as a measure of environmental impact. Significant savings in energy use and carbon dioxide emissions are clearly possible through environmentally aware choice of building products.

Résumé
Il existe quantité d'informations sur l'énergie utilisée dans la construction des bâtiments, mais ce n'est que récemment que l'attention s'est portée sur l'énergie nécessaire à la production et au transport des matériaux de construction. Celle-ci, souvent appelée « embodied energy », revêt une importance grandissante dans l'évaluation des conséquences de ces activités sur l'environnement et le combat pour la réduction des émissions de gaz à effet de serre. Cet article commente les techniques de calcul de cette énergie et se penche sur les points forts, mais aussi les faiblesses de ce facteur en tant que moyen de mesure de l'impact sur l'environnement. Il en ressort clairement qu'il est possible de réaliser des économies d'énergie significatives ainsi qu'une réduction importante des émissions de dioxyde de carbone en recourant à des matériaux qui respectent l'environnement.

Resumen
Existe una gran cantidad de información sobre la energía usada en las construcciones, pero hasta hace muy poco tiempo, no se había prestado mucha atención a la energía utilizada para producir y transportar los productos de construcción. Esta energía, a menudo llamada "energía incorporada", tiene cada vez más importancia dentro del contexto de la estimación de los impactos medioambientales y la lucha por la reducción de las emisiones de gas que puedan contribuir al efecto invernadero. Este artículo analiza las técnicas para calcular la energía incorporada y considera los puntos fuertes y débiles al utilizarla para medir el impacto medioambiental. De otra parte, muestra cómo al seleccionar productos de construcción, teniendo en cuenta su impacto medioambiental, se pueden alcanzar ahorros considerables en la utilización de energía y en la emisión de dióxido de carbono.

Introduction

There is now wide recognition that we risk damaging the environment which sustains life, perhaps irreparably, if we do not take measures to reduce the impact of man's activities. At a global level this has led to several major international initiatives, including the 1992 Earth Summit in Rio de Janeiro which addressed the threat of climate change resulting from emissions of greenhouse gases. Together with many other countries, the UK committed itself to reducing emissions of the main greenhouse gas, carbon dioxide, by signing the International Climate Change Convention.

Energy used in buildings accounts for almost 50 per cent of the emissions of carbon dioxide in the UK; in 1990, for all energy uses, this amounted to 579 Mt (Shorrock and Henderson, 1991). The UK Department of the Environment (DOE) has a number of programmes designed to underpin the UK's Rio commitment through promotion of energy efficiency and identification of techniques for reducing greenhouse gas emissions due to energy used in the construction and operation of buildings. The DOE has sponsored research at Building Research Establishment (BRE), and our work has shown that there is the potential to reduce the UK's carbon dioxide emissions by around 20 per cent through the use of cost- effective energy efficiency measures in buildings.

Why the work is being done

Whilst there is a considerable amount of information available about the energy used in buildings, until recently little attention has been paid to the energy used to produce and transport building materials and products. This energy is often called the "embodied energy". As improvements in the energy efficiency of buildings are made, the relative importance of the embodied energy grows because it forms a higher proportion of the total. BRE's initial work, based on the analysis of economic input-output tables for 1984, indicated that the energy used to produce building materials contributed about 8 per cent of the UK's carbon dioxide emissions. In Japan and Australia, the carbon dioxide emissions resulting from building product manufacture are much higher at about 17.5 per cent and 20 per cent of the national totals respectively (West, 1995). One of the reasons for carrying out this work is to identify the potential for savings in energy use and in carbon dioxide emissions through informed selection of building products. Work carried out in New Zealand (Honey and Buchanan, 1992) and Canada (Russell, 1991) has indicated that considerable savings could be made in the initial embodied energy and associated emissions of carbon dioxide by using alternative components.

Price has traditionally dominated the selection of building products, but a growing number of architects and clients are recognizing the importance of building performance and the effects of the building on the environment over its entire life cycle. Producers have been quick to recognize the commercial potential of environmental issues and have been using them in their promotional material. However, there is no accepted standard for assessment of environmental performance and it is difficult to verify their claims to be more environmentally friendly than their competitors.

It is important to recognize that embodied energy is just one environmental issue. Many other factors associated with the whole life cycle of a building need to be taken into account. Some of the more important issues are summarized in **Box 1**. Energy use has received much attention, not only because of its relation to the emission of carbon dioxide but also because it is one of the few environmental factors for which absolute values can be calculated. BRE's work on embodied energy is designed to develop an acceptable and comparable way of calculating embodied energy (and emitted carbon dioxide) for building products and incorporate this as one component in a tool for use by architects and designers, in order to help them select the most environmentally benign product for a particular building.

Approach taken

As mentioned above, BRE's initial work on embodied energy was based on an analysis of economic input-output tables, square matrices which summarize the commodities necessary to make other commodities. This work indicated that some 350 PJ of energy was used each year in the production of building materials, which was responsible for about 8 per cent of the UK's carbon dioxide emissions (West et.al., 1994). The input-output analysis indicated that the majority of the energy used to make building products was associated with the production and transport to site of aggregates, cement, clay bricks, wood, glass, steel, and plaster and plasterboard.

The figures were refined using some process data. These values were then used in a spreadsheet model to calculate the effects of varying the specifications for offices, both initially and over the projected design life of the building. The spreadsheet model was created by breaking building specifications into elements, further dividing these elements into materials and components, calculating the embodied energy of these materials and components, and then calculating the embodied energy for the building elements. After the specifications have been selected, the spreadsheet calculates totals for embodied energy and emitted carbon dioxide for each building element and each building design. For simplicity in making these calculations, all the energy and fuel sources for processing are aggregated using energy and emitted carbon dioxide equivalents. Aggregation of these data results in loss of information about environmental effects – for example, electricity is generated partly from fossil fuels but also from nuclear, hydro and other renewable sources, each of which have different environmental impacts.

Calculations using these figures indicated that initial embodied energy savings of 20 per cent or more could be achieved through the selection of lower embodied energy materials. It was also clear that values for the embodied energy of products based on input-output analysis were not sufficiently reliable to enable valid decisions about energy benefits to be made. There can be a wide variation in both the specification and embodied energy of similar products, and this is not reflected in single embodied energy values based on input-output data or industry averages. Consequently, attempts have been made to use the analysis of individual processes to produce embodied energy values for particular products. A number of these values have been published in the literature. For any material there is a wide range of values, due not only to variations in efficiency of plants and processes but also to factors such as:

1. different assumptions about the scope of the calculations (system boundaries);
2. different methods of calculation and data sources;
3. different assumptions about the modes of transport for imports and distribution;
4. quoting of embodied energy figures in terms of in delivered or primary energy;
5. quoting of figures in terms of initial embodied energy or life cycle embodied energy.

Clearly, comparisons between products and designs cannot be made using values calculated with such varied assumptions. For this reason, BRE is working with industry to develop a standard methodology for calculating embodied energy which will be suitable for calculating both site-specific values and industry averages. The methodology is based on life cycle analysis, which is becoming an increasingly important tool in the assessment of environmental impacts of all kinds.

Box 1
Life cycle stage and possible environmental issues

Stage	Possible environmental issues
Raw materials extraction	Ecosystem loss, finite resource loss, amenity loss, noise, dust, hydrogeological effects, transport infrastructure effects, air and water pollution.
Manufacture	Energy consumption, finite resource loss, air and water pollution, noise, dust, effects on ecosystems, global warming, acid gas emissions, ozone depletion.
Distribution	Energy consumption, noise, dust, global warming, acid gas emissions, air and water pollution, effects on ecosystems
Construction	Noise, dust, air and water pollution, emission of hazardous substances, effects on ecosystems, packaging, waste minimization, good construction practice, ozone depletion.
Building in use	Energy consumption, durability, maintenance requirements, replacement frequency, ease of replacement, global warming, acid gas emissions, waste water, soil contamination, ozone depletion.
Demolition and recycling	Noise, dust, reuse, contamination of soil, energy consumption, global warming, acid gas emissions, ozone depletion.

Life cycle analysis

This technique originally described the performance of industrial systems in terms of the inputs of energy and raw materials and the outputs of products and wastes (gases, liquids and solids). The original aims of life cycle analysis (LCA) were to compare alternative processes, improve the efficiency of individual processes (i.e. to use less energy and raw materials and produce less waste), and in some cases to provide information to interested parties on resource use and releases. As environmental concerns have grown, the scope of work on LCA has been extended to assess impacts on the environment and to identify ways of reducing these.

The concept of the life cycle of any product is simple. For illustration, consider a door. **Figure 1** is a simple outline of the life cycle of a door, which shows that all raw materials and component parts must be traced back from the manufacturing processes to the biosphere. Similarly, all raw materials and components must be traced forward to the biosphere through the packaging, transport, use, maintenance and disposal stages in the life cycle. It can be seen that any life cycle interacts with many other life cycles. A complete life cycle study would involve almost infinite regression. It was hoped, that through a structured cradle to grave approach such as this, it would be possible to distinguish between environmental impacts of products, identify product improvements, and award environmental labels (Vis, 1995). However, as more life cycle studies have been carried out, their limitations have become apparent. Not surprisingly, because of the complex nature of the task, most life cycle analyses have considered only a small part of the life cycle. It is also not always possible to obtain the necessary data, as they are often confidential. The outputs from these life cycle analyses have been long tables which are difficult to evaluate in terms of environmental impact. As a consequence, it has proved impossible to make objective life cycle performance comparisons between products. The calculation of embodied energy is essentially a major component of a life cycle analysis. In defining a methodology for calculating embodied energy and emitted carbon dioxide for building materials, BRE is also setting out a framework for life cycle analysis.

Methodological framework

BRE is currently finalising its methodological framework for the calculation of the embodied energy of building materials. For the purposes of the framework, BRE's definition of embodied energy is "the total primary energy that has to be sequestered from a stock within the earth in order to produce a specific product." It is hoped that the framework covering the methodology for calculating life cycle embodied energy of a building product up to the factory gate will be ready for publication towards the end of this year.

This framework builds on earlier work carried out by others in the LCA field, but most particularly that of the Society for Environmental Toxicology and Chemistry (SETAC), which has published guidelines for carrying out life cycle studies (SETAC, 1993). These guidelines are not absolute rules, and BRE's work has interpreted the guidelines specifically for the calculation of embodied energy and emitted carbon dioxide of building materials. A major requirement is that the methodology should be fair and transparent, and as far as possible, based on the principles of thermodynamics. There is no single, right answer to how the calculations should be carried out, rather a range of options which are better or worse suited to specific aims. A second requirement was that, as far as possible, the methodology should be acceptable to manufacturers and producers.

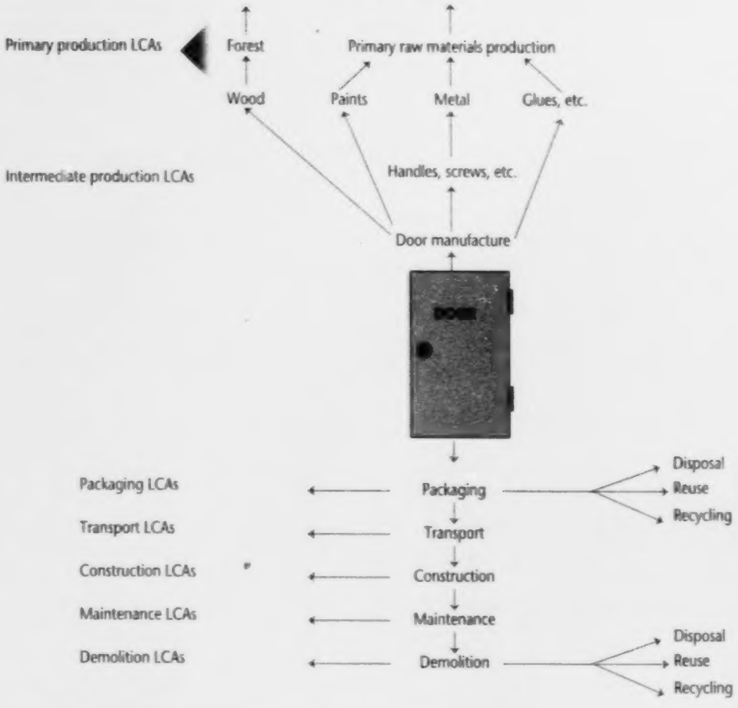
The conventions covered by the framework include: the scope of the calculations or the system boundaries; the definitions of primary energy, including how to account for calorific values of raw materials and renewable and nuclear energy sources; allocation of energy values when more than one product is produced; capital equipment; transport; scrap; recycling; data sources and verification; presentation. The framework will also include conventions for process-related emissions of carbon dioxide; for example, the calcination of limestone in the production of cement releases carbon dioxide.

Future work

BRE is also investigating the energy costs associated with the transport of building products and will be incorporating other aspects of the life cycle - particularly repair, maintenance, refurbishment and demolition – into its model. Work on these other aspects is already under way in other parts of BRE's programmes on environmental issues. Some of this work is being carried out in conjunction with other European building research institutes, including those of Belgium, Denmark, Finland, France, the Netherlands, Italy, Norway and Sweden. This work is in part funded by the EU's Brite-Euram programme.

Of particular importance in calculating the life cycle embodied energy associated with a particular building is the need to know the design life of the building, together with the maintenance requirements and expected life of its component parts. This is particularly difficult to calculate, as it depends on a wide range of factors including the quality of products, "buildability" of the design, construction practices, materials compatibility, and the effects of the environment on the building. However, there are data available which can be adapted and used for both life cycle embodied energy calculations and life cycle costing (a related technique which allows the calculation of the economic costs associated with the selection of materials). Some preliminary calculations based on these data indicate that, when repair, maintenance and refurbishment are taken into consideration, the embodied energy in some new, well insulated buildings could account for as much as 50 per cent of the energy used to run them over a 25-year period. This shows the importance of considering life cycle energy costs when comparing materials. Ultimately BRE's model will include all these aspects of embodied energy and a wide range of other environmental impacts.

Figure 1
Life cycle of a door



Each LCA should include LCAs of energy, plant, building, etc.

Reuse and recycling of building materials and a greater use of wood, particularly locally grown, also have the potential to reduce net energy use and carbon dioxide emissions associated with construction and may have other environmental benefits. Similarly, steel and aluminium in buildings can have high initial embodied energy costs, but over a number of "life cycles" the energy penalties are reduced as the metals can be separated and recycled. Building design can positively influence these processes. With most materials there is potentially a resource problem due to diminishing supplies of raw materials. This need not happen for wood, which, being a renewable material, is likely to become increasingly important for building. Increasing woodland for timber production may have environmental benefits such as absorption of carbon dioxide and reduced soil erosion. To facilitate more use of timber in the future will require increased forward planning, and this should not be overlooked in plans for sustainable development.

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Calculating the environmental impacts of buildings

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Introduction: calculating environmental impacts of buildings from cradle to grave

Buildings are studied through various methods in Europe. One could think of the "Opteco/Projeco" method developed by N. Kohler and Y. Leuridan in Germany and the Bream method developed by the English Building Research Establishment (BRE).

Life Cycle Assessment is widely recognised as a method which brings the best results in studying the environmental impacts of products. It is standardised at the International level through the ISO DIS 14 040.

The Life Cycle assessment method has been applied by the Ecobilan Group to the building sector. Moreover, software ("TEAM™ for Building") has been developed to simulate buildings for the French ADEME (Agence de l'environnement et de la maîtrise de l'énergie), in co-operation with the French CSTB (Centre Scientifique et Technique du Bâtiment).

The object of this article is to present how the method has been adapted to the building sector through our studies, and to present the main applications that can be envisaged for the " TEAM™ for Building " tool.

Chronological point

First, some industrial case studies were completed. They mainly dealt with the comparative study of different structural solutions (wood, steel, concrete) and tried to determine which was the best solution, given the circumstances and parameters.

Next, some theoretical studies were carried out in order to examine the key points of the of Life Cycle Analysis method in relation to materials (concrete, cement, window glass, tar for watertightness).

Finally, a complete study assessed the environmental burdens of buildings, encompassing the construction stage and building use over a given period of time. This study was at the origin of the development of the " TEAM™ for Building "software.

Main points of the method

The first stage of a study in the building sector is to define:

- the functional unit (i.e. used to calculate flows in the life cycle);
- the studied system;
- nature and sources of the data;
- assumptions of the calculation.

The functional unit is multifunctional. It has to take into account different parameters which define the level of comfort of the building for a certain number of years. This functional unit will depend on the objectives of the study.

In a second part, the use period, the frequency of the renovations, the behaviour of the users and the physical boundaries of the building should be defined to precise the studied system.

In a last part, a study should define first the data to be gathered and the calculation assumptions which are specific to the building sector.

The complete methodology is presented in a report which is available at the French ADEME.

" TEAM™ for Building " software

The " TEAM™ for Building " software which was developed specifically by Ecobilan to carry out Life Cycle Assessments.

A life-cycle database has been developed to describe the production of building materials and the different building construction and use phases (concrete pouring, plumbing, painting, etc.).

Based on this tool, the user can calculate the environmental impacts of a building's life-cycle by modifying specific parameters. In fact, the user has to implement two sets of parameters:

1. parameters describing the building, such as square metres of window pane, square metres of insulated surface, numbers of bath tubs, type of energy used for the heating system, etc.;
2. parameters related to the use of the building, such as the annual energy consumption (heating and hot water), number of inhabitants, etc.

The user has to ensure the consistency of the parameters. For instance, the energy consumption of the building is highly dependent on the insulated surface.

Given a consistent set of parameters, "TEAM™ for Buildings" calculates the environmental impacts of the corresponding building life-cycle (depletion of natural resources due to its construction and use over a given period of time, potential green house effect, etc.).

The nature of the parameters, as defined above, enables the user to perform sensitivity analyses on construction material, building equipment, type of energy used in the building, etc.

Applications

The main application of this tool is to help the designer of a building during its conception in order to design High Environmental Quality Buildings.

Thanks to this tool, the designer can study various solutions and then choose the best environmental one.

Another possibility of this tool is to integrate the results of specific studies which calculate lifetime energy or water consumption and waste production.

Conclusion

Life Cycle Assessment is now applied through a generic tool which can "learn" and benefit from all studies made using it. Co-operation between foremen, designers, and scientific and expert offices is needed in order to consider the numerous building methods and to give a large choice of environmental solutions to designers.

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Towards sustainable production systems: closing the loops

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Abstract

The fast-growing Indian construction sector is that country's single largest contributor of CO_2 emissions. This sector is characterized by increasing shortages of conventional building materials, and by technologies that use resources and energy inefficiently. A response strategy has been devised to meet the growing demand for building materials while limiting emissions. To increase the supply of walling materials, Sustainable Production Systems have been defined. An eco-design case study is presented of TARAGRAM, an appropriate technology resource centre in central India whose production system closes the loops for the generation and sustainable utilization of water, biomass and energy resources.

Résumé

En Inde, le secteur du bâtiment, en forte croissance, est le plus grand producteur de CO_2. Il se caractérise par des pénuries de plus en plus importantes de matériaux de construction classiques et par des technologies qui n'utilisent pas l'énergie de façon efficiente. En réaction à cette situation, une stratégie a été mise au point dans le but de satisfaire la demande toujours croissante de matériaux tout en limitant les émissions de CO_2. Afin d'augmenter la quantité disponible de matériaux destinés au gros-oeuvre, des Systèmes de Production Durable ont été créés. L'article présente une étude de cas de l' «éco-conception», celle de TARAGRAM, un centre de ressources technologiques adaptées, situé au centre du pays. Le système de production mis en place dans ce centre boucle la boucle car il couvre l'ensemble des étapes de production et d'exploitation durable de l'eau, de la biomasse et des ressources énergétiques.

Resumen

En India, el sector de la construcción (un sector de rápido crecimiento) es el mayor responsable de las emisiones de Co_2. Este sector se caracteriza por un déficit creciente de materiales de construcción convencionales y por tecnologías que utilizan los recursos y la energía de una manera ineficaz. Para satisfacer la demanda creciente de materiales de construcción, limitando al mismo tiempo las emisiones de Co_2, se ha concebido una estrategia de respuesta. Con este fin, y para proporcionar materiales para la construcción de paredes, se han definido los Sistemas de Producción Sostenibles. Por otra parte, se presenta un estudio de caso de diseño ecológico realizado por TARAGRAM, un centro de recursos tecnológicos adecuados en India central. Su sistema de producción cierra el círculo para la generación y la utilización sostenible de los recursos hídricos, de biomasa y energéticos.

The construction sector in India is a major user of natural resources, energy, manpower and capital. It is also the single largest sector, responsible for 22 per cent of total emissions. This sector is slated to grow continuously, with projected 4.6 per cent annual economic growth resulting in increased affordability and a marked change in consumption patterns. There is also a trend towards increasing use of energy-intensive building materials. Further, there is a backlog amounting to 18 million houses, with diminished availability of biomass materials (wood, thatch) and a saturating supply of conventional materials (stone, slate). It has been established that the major energy users in the building materials industry are the producers of cement, steel, bricks and lime, which together contribute 80 per cent of total emissions in the construction sector. Current demand for these four materials requires energy amounting to 743 PJ, with a corresponding 81 million tonnes of CO_2 emissions. In the specific case of cement, per capita consumption is expected to increase from the existing level of 60 kg to 210 kg by the year 2020. The latter figure is equivalent to current consumption in developed countries. The projected demand for these four building materials, for the period 1990-2020, is shown in **Figure 1**.

As these materials are largely material-intensive, their use puts increasing pressure on natural resources and on non-renewable energy resources. It is expected that, by the year 2020, their use will result in a three-fold increase in energy requirement. The corresponding emissions will escalate to 285 million tonnes of CO_2. These projections are based on current technology mixes prevalent in the respective manufacturing sectors. Besides putting immense pressure on natural resources, this trend will mean a 4.3 per cent per year increase in emissions and a doubling of emissions in per capita terms. Such a trend is clearly unsustainable.

Strategy for sustainable building technologies

The demand trends for walling and roofing show a transition to engineered and high-energy material alternatives. This is bound to give rise to a shortage in the materials required for building construction. The supply gap, evident in the case of burnt bricks for walling and stone and slate for roofing, is a natural consequence of the limited availability of natural resources such as clay and the conflicting requirements for limited energy resources. The normal response is to rely on improving energy efficiency within the basic material production sector. This response is seen in the cement and steel industries, which are acquiring new technology to achieve high standards of energy efficiency and environmental performance. The impact of technology measures alone on reducing emissions, within the context of the four major building materials, will be significant under the growth conditions projected for production of basic building materials. An assessment of the technology alternatives likely to be adopted has been made.

Technology alternatives

Three distinct scenarios have been developed by Development Alternatives in order to understand the impact of wide adoption of these technology options on net energy demand and resultant emissions.

1. The first scenario, Technology as Usual (TAU), is evaluated on the basis of the entire projected future demand being met with the current mix of technologies. The proportion of production using each existing technology is expected to remain unchanged.
2. The Best Practice (BP) technology option requires that all production capacity, both existing and new, conform to the Best Practice technology currently available.
3. The third option superimposes New Technology (NT) for all additional capacity, with the capacity of 1989-90 conforming to Best Practice technology.

In a situation where demand is expected to grow exponentially, the cumulative energy requirement for the four materials is expected to increase from 742 in 1989-1990 to 2363 PJ by 2020, under the TAU scenario. The introduction of BP has a net positive impact, reducing energy consumption by 17 per cent to 2000 PJ in the year 2020. On the basis that all new installed capacity conforms to the new technology available, the total energy saving possible is 563 PJ, equivalent to 25 per cent of the total energy that would be consumed using present technologies. These projections reflect the energy savings possible through technology intervention alone, with the projected demand for building materials fully met. Clearly this is not enough.

The reduction of emissions and a positive impact on resource efficiency can become significantly greater through promotion of low-energy building material alternatives and options which rely on highly efficient use of energy-intensive materials like cement and steel. There is evidence from various parts of India that new walling materials, timber substitutes, and roofing alternatives can be adopted within a reasonable time frame and on a wide scale. For walling, stone-cement blocks have been widely accepted in areas where burnt brick production is no longer economically feasible or the cost of transportation has become excessive. Ferro-cement and micro-concrete roofing tiles have in recent years achieved wide acceptance, especially in areas where stone crusher waste is locally available.

Any strategy for improving housing through sustainable building technologies will need, on one hand, to augment the supply of building materials to meet demand and, on the other, to integrate ecological design concerns into the delivery process. The sustainability of such a strategy will require consideration of factors such as local availability, decentralized production systems, resource efficiency and materials movement. This in turn requires integration of a Sustainable Production System for building materials with techno-economic packages for efficient delivery. The key elements of the strategy are illustrated below. Two of the main processes discussed are:

- augmentation of supply: a case study concerning walling;
- TARAGRAM: a study in eco-design.

Figure 1
Projected demand for building materials (1990-2020)

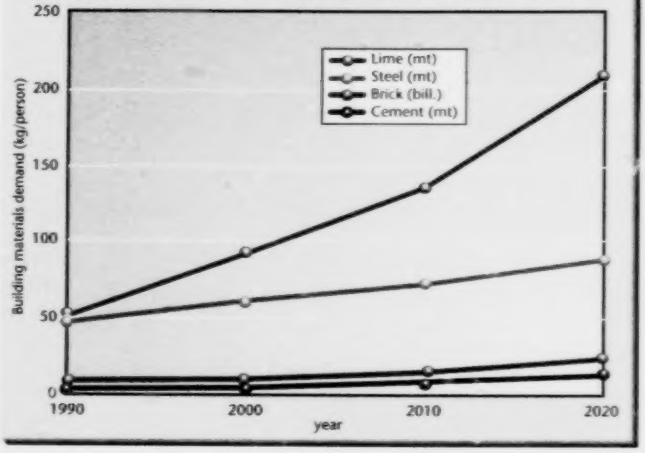


Figure 2
Impact of technology on net energy demand for four building materials

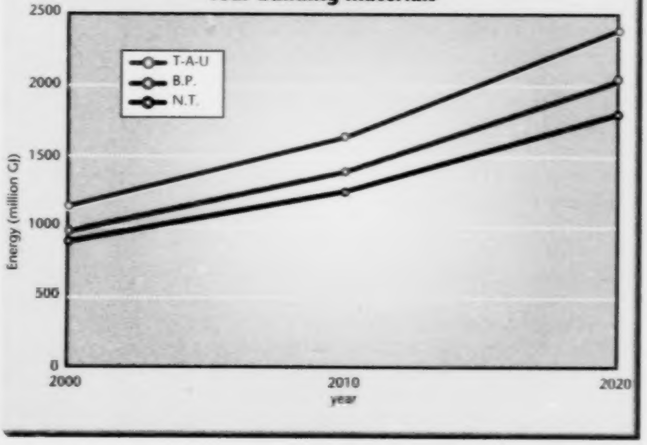
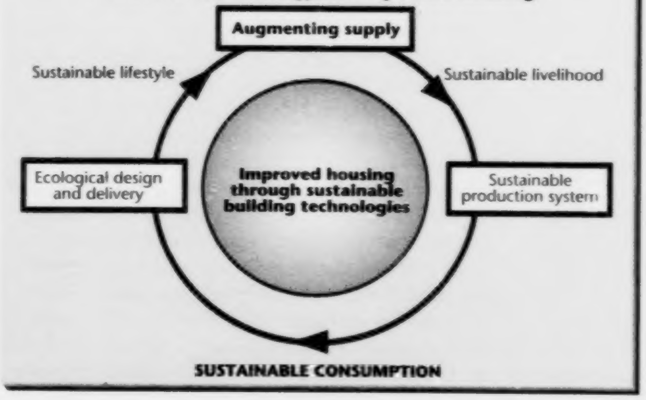


Figure 3
Elements of a strategy for improved housing


Augmenting supply
Sustainable lifestyle
Sustainable livelihood
Ecological design and delivery
Improved housing through sustainable building technologies
Sustainable production system
SUSTAINABLE CONSUMPTION

Augmentation of supply: a case study concerning walling

There is clear evidence of a levelling off in the supply of conventional building materials such as burnt bricks and slate. On the basis of a projected demand for 45.31 billion bricks in 1990, the projected demand for 2020 is 89.1 billion. According to the projections of the Planning Commission for the VIII plan period (1992-97), later verified by the Building Material and Technology Promotion Council, brick production is likely to reach the saturation point at about 46.5 billion. This is attributed to the limited availability of clay of requisite quality, coupled with restricted availability of fuel and increasing environmental concerns regarding the operation of brick kilns. Thus a strategy for reducing emissions can only be seen in the context of fulfilling demand through assuring supply.

The effective augmentation of supply can only take place while incorporating efficient utilization of resources. For walling, burnt brick production is the dominant factor and can only be sustained through major improvements in technology. Use of Best Practice technology results in a 10 per cent increase in energy efficiency. The newly introduced Vertical Shaft Brick Kiln (VSBK) technology is likely to improve energy efficiency up to 30 per cent. The shortfall in supply is likely to be satisfied by stone-cement and concrete blocks. A series of technology measures have been incorporated in order to develop different scenarios for walling, characterized as follows:

- Using Technology as Usual, all brick production would be carried out with the existing mix of technologies.
- Best Practice technology would be adopted for all brick production, (limited to 46.5 billion per year).
- The supply of walling material in the period 2000-2020 would be augmented by stone-cement and concrete blocks.
- Twenty-five per cent replacement of brick production up to 2020 would be achieved through the introduction of new technology (e.g. VSBK).
- Twenty-five per cent replacement of bricks up to 2020 would be achieved through use of low-energy alternatives (e.g. compresssed earth blocks, flyash products).

The impact of each of these measures has been evaluated in terms of energy requirements, energy savings possible, and resource utilization. The adoption of Best Practice for 46.5 million bricks results in a saving of 3.3 million tonnes of coal by 2000. Substitution by concrete blocks further limits the energy requirement, resulting in a saving of 14 PJ in the year 2000, growing to a saving of 40 PJ by 2020. A partial replacement of existing brick kilns by VSBK technology brings down the energy requirement even further. The maximum saving that can be achieved while fulfilling the demand requirements is 4.4 million tonnes of coal for walling purposes alone in 2000, growing to 7 million tonnes by 2020.

The choice of technology clearly needs to be region-specific, taking account of building practices, raw materials and environmental imperatives. In addition to energy efficiency, Sustainable Production Systems need:

- full accounting of resources, especially proper

energy pricing; and
- decentralized production of building materials.

Energy pricing

The manufacture and distribution of cement entails significant transportation costs for finished goods and energy costs for manufacturing. As the use of cement and cement products grows, energy pricing will have to be increasingly rationalized. The fuel cost per metre of walling in the case of concrete blocks is Rs.11/-, for a net energy consumption of 164 MJ in terms of primary energy used. In the case of burnt bricks, the cost of fuel is considerably higher at Rs. 40/- per square metre, mainly due to the cost of coal. The corresponding energy for walling from burnt bricks is 495 MJ.

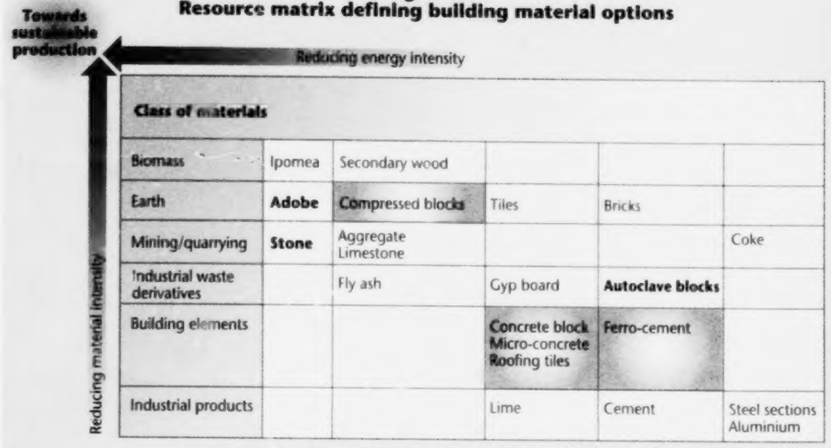
An analysis of fuel costs per unit of energy using Best Practice in cement and brick manufacture provides some valuable insights. The cost per unit input energy being paid by the large cement industry for high-quality coal, electricity and diesel appears to be only 80 per cent of the price for equivalent fuel estimated in brick manufacture. A policy that prices fuel equally for both materials without taking account of transportation costs would result in an increase in fuel costs for the cement industry from Rs. 470/- to 560/- per tonne. This factor is even more important in view of the long distances over which cement is presently transported because of highly subsidized transportation costs. Though the suggested pricing is only indicative, the whole issue of energy costs, particularly in relation to electricity and diesel, needs to be examined in greater detail. Moreover, these costs are assuming greater importance in view of the current trend to provide large electricity generation capacities using diesel generating sets.

Decentralized production

From the previous section, it has become evident that energy efficiency up to 25 per cent could be achieved through improved production processes. However, the augmentation of supply can be achieved through wide use of cement-based blocks and judicious substitution of natural materials with industrial waste and low-energy derivatives. With these measures, the total energy requirement can be reduced 50 per cent compared with the requirement for present production and usage, while still meeting demand. Some of these low-energy alternatives are compressed earth blocks, manually compressed using cement and lime as stabilizers, and fly ash-lime blocks produced through mechanical compaction. A wide variety of stone-concrete blocks can be produced using a cement matrix with different grading of stones and stone crusher waste. Each of these materials can be produced by decentralized workshops located near the source of materials. In the case of concrete blocks and micro-concrete roofing tiles, there is ample evidence of the economic viability of decentralized production and marketing systems.

Sustainable Production is achievable by simultaneous reductions in material and energy intensity. Different building material options can be located within a Resource Matrix (**Figure 4**) which defines the path to be followed in regard to emerging building products and technologies. Some of these options are described in the next section.

Figure 4
Resource matrix defining building material options


Towards sustainable production
Reducing energy intensity
Reducing material intensity

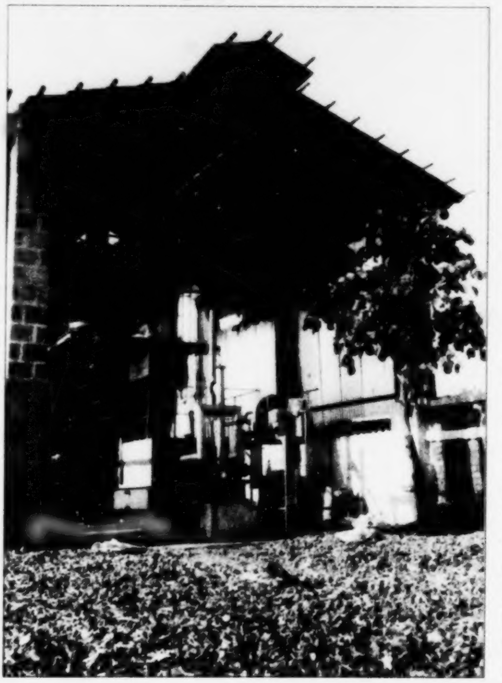
Class of materials					
Biomass	Ipomea	Secondary wood			
Earth	**Adobe**	Compressed blocks	Tiles	Bricks	
Mining/quarrying	**Stone**	Aggregate Limestone			Coke
Industrial waste derivatives		Fly ash	Gyp board	**Autoclave blocks**	
Building elements			**Concrete block Micro-concrete Roofing tiles**	**Ferro-cement**	
Industrial products			Lime	Cement	Steel sections Aluminium

TARAGRAM: a study in eco-design

Eco-design

Any sustainable society must be based on design processes and production systems that are sensitive to ecosystem limits. Energy and material flows must be minimized and, to the extent possible, local resource flows given preference over long-distance ones. The construction sector is responsible for the built environment, including shelter and infrastructure. It draws heavily on the resources of the earth and can cause extensive damage to the natural environment. The design and construction of human settlements and industrial units must therefore take special care to integrate the satisfaction of human needs with concerns for resource efficiency and economic viability.

Figure 5
100 kW gasifier at TARAGRAM

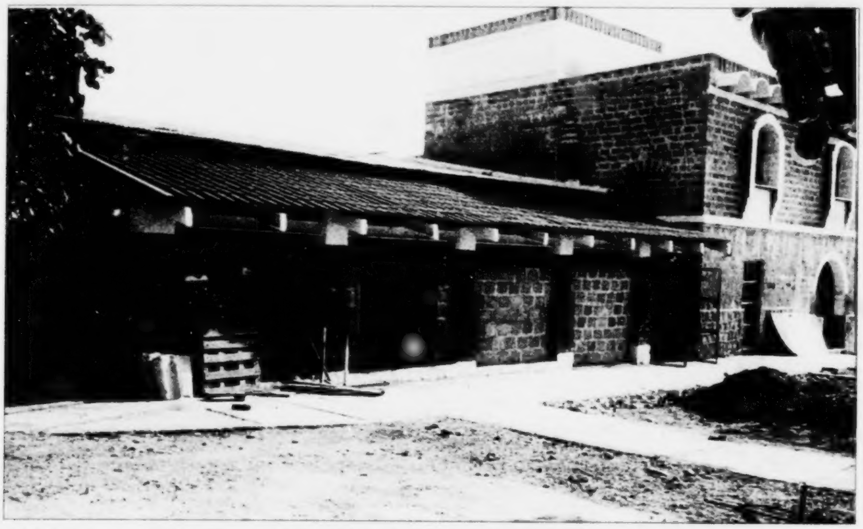


TARAGRAM is the appropriate technology resource centre of Development Alternatives, located in Orchha in central India. (TARA, which stands for "Technology and Action for Rural Advancement", is the brand name of the products of Development Alternatives. *Gram* in Hindi means village.) The mission of TARAGRAM is to develop techniques and institutions that can regenerate the resource base and make it available for utilization in an efficient, equitable and environmentally sound manner. TARAGRAM serves as a model to bring together social, environmental and technological knowledge to generate sustainable livelihoods through decentralized production systems. Such livelihoods are needed in large numbers throughout the developing world to improve material standards while maintaining the physical resource base.

TARAGRAM manufactures products using local raw materials. At present, these include paper, building materials and energy; new ones are being added continually. In addition to serving as a demonstration facility for such livelihood technologies, TARAGRAM provides on-the-job and course-based training for personnel from micro-enterprises that wish to set up similar plants.

The captive power plant converts renewable biomass fuels (including mainly local agro-wastes and unusable weeds) into 80 kW of electricity using a highly efficient gasifier and diesel generating set (**Figure 5**). The power plant will shortly be working at its full-rated capacity of 100 kW. A pyrolysis unit also generates excellent charcoal from local biomass. These fuel conversion technologies have been developed by various research institutions in India and are optimized for local conditions. The electricity generated supplies the needs of the entire campus, including the manufacturing plants, training es-

Figure 6
Building production from waste: stone-cement blocks, ferro-cement channels



tablishment, artisans' village, and other facilities for community interaction such as an open air theatre.

The handmade paper unit, a micro-enterprise based on front-line technology designed by Development Alternatives, employs more than 70 people, mostly women who earlier had no source of income. Its raw materials include cotton rags from nearby urban markets and textile mills, used paper, and waste biomass. The paper unit occupies more than 500 square metres of covered and open areas for pulping, lifting, drying and finishing. The layout and placement of work stations have been carefully designed to simplify and reduce movement of materials, energy and people, leading to considerable savings in piping, wiring and human effort.

Indeed, the basic design principles of the entire village seek to maximize the functionality of the production facility and minimize the use of external energy and the movement of raw materials, water, finished goods, and people .

The design and materials for the building were also chosen to maximize the use of local skills and building forms. The structure therefore uses a series of arches built with hand-moulded stone-concrete blocks (**Figure 6**). Where the building is not exposed to water, the walls are made of compressed earth blocks. In dry areas, the roof is covered with Tara micro-concrete roofing tiles (TARACrete) and supported by steel trusses made from locally available used boiler tubes. The roofing tiles are coloured green to blend with the foliage. To maintain the high standards of cleanliness needed for paper finishing, the roof is made of ferro-cement channels.

The materials used for construction are largely of low to medium energy intensity. Energy intensity can be classified as follows:

- low energy intensity: on-site materials and recycled materials – up to 5 km radius;
- medium energy intensity: local materials – up to 50 km radius;
- high energy intensity: industrial products – up to 500 km radius.

Wherever possible, we have used waste and recycled materials available locally . Use of industrial building products has been minimized. Resource utilization for the construction of TARAGRAM is shown in **Figure 7**. The entire TARAGRAM complex averages 0.12 tonnes of cement and 4.5 kg of steel per square metre of construction, compared with conventional building technologies which consume 0.21 tonnes of cement and 14.5 kg of steel for a building with the same performance.

Water management

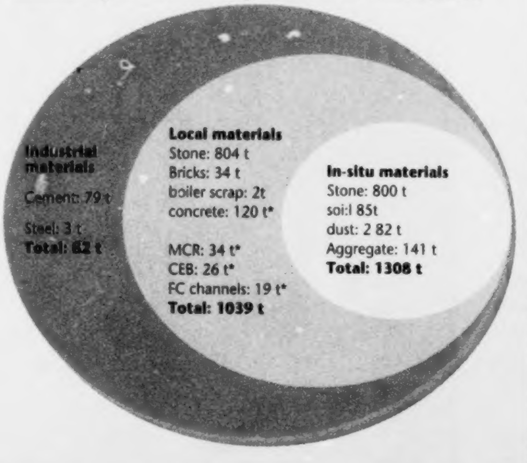
Being a production facility, TARAGRAM needs assured water throughout the year. In fact, its requirement is approximately 100,000 litres of fresh water per day. Designing the site for sustainable water management therefore assumed prime importance. The initial site work was entirely devoted to water conservation structures, including gully plugs and drainage channels.

To ensure adequate ground water recharging, a checkdam has been constructed on a stream that borders the site. The reservoir thus created retains water throughout the year and ensures adequate charging into an open well, which is the main source of water for TARAGRAM operations.

The geo-hydrological formations fortunately ensure that the water is potable. Because of the recharge caused by the checkdam, and in contrast to most other places in the area, water is available throughout the year.

Within the paper manufacturing process, great care has been taken to recycle the water as much as possible. While the total water requirements of the paper production unit are 115,200 litres of water per day, recycling and selective grading of more than 50 per cent of the water reduces the requirement for fresh water to less than 55,000 litres. Finally, the water leaving the paper production process is passed through settling tanks to reduce total dissolved solids. The treated water is directed to the building material section for a second reuse. A small quantity of the treated water is also used for watering the site and for horticulture. The water discharged from other production processes is allowed to percolate through the gully plugs provided on-site, to effectively close the loop.

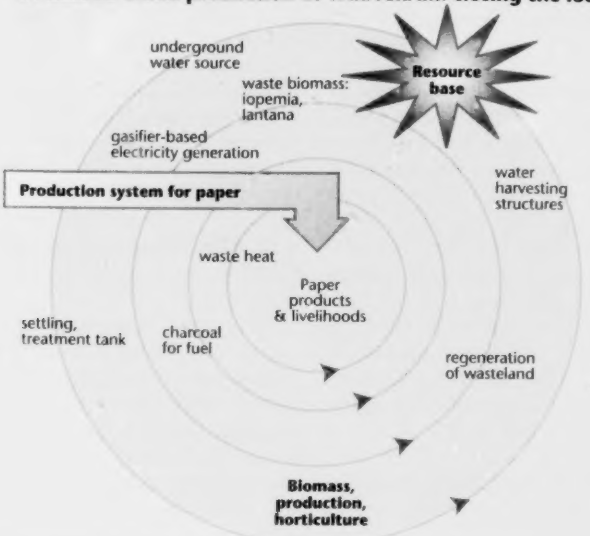
Figure 7
Material procurement by distance at TARAGRAM



Energy requirements

The energy requirements of TARAGRAM are primarily electrical energy for motors and pumps; heat energy for assured drying of paper and water heating; and cooking energy for site requirements. Several alternatives were explored for setting up a power-generating utility based on self-sufficiency and the use of renewable resources. As a result, the 100 kW power plant uses a biomass gasifier based on technology developed by the Indian Institute of Sciences of Bangalore together with a commercially available diesel generating set. The gas generated replaces as much as 90 per cent of the diesel fuel needed for producing electricity. Even though wood-based gasifiers have been operational for some time in India, their effectiveness for non-wood biomass fuels has not been established. The biomass-based gasifier, designed specifically for TARAGRAM, relies on the use of Ipomea, a biomass waste available along most of the water bodies and stagnant streams in the region. An initial assessment of local availability has established renewable resources of Ipomea of approximately 500 tonnes per year, more than sufficient for the one tonne per day required for the power plant. There is no conflict involved in the use of this material, since it has no other uses. Environmentally, since it is pyrolized in the gasifier and not burnt in the open, the emission of toxic fumes is avoided. This unit has been commissioned and is working efficiently. The collection and preparation of the Ipomea has also led to the setting up of small household enterprises.

Figure 8
Livelihood-based production at TARAGRAM: closing the loops


underground water source
Resource base
waste biomass: iopemia, lantana
gasifier-based electricity generation
water harvesting structures
Production system for paper
waste heat
Paper products & livelihoods
settling, treatment tank
charcoal for fuel
regeneration of wasteland
Biomass, production, horticulture

The waste heat from the exhaust system and the cooling water will be utilized for drying paper and biomass products. A heat exchanger system with forced convection is being set up to extract approximately 60 kW of heat equivalent for drying operations. The cooking energy requirements are met through waste char, which is produced during regular maintenance and cleaning of the gasifier system. It is proposed to tap part of the producer gas and use it directly for thermal applications. This system will be set up only after safety aspects have been duly established.

The design of the production system is based on inputs of biomass and recycling of wastes. The biomass can be effectively regenerated by efficient management of land and water resources. Closing of the loops for water, biomass and materials is shown in **Figure 8**. The net outputs of this system are sustainable livelihoods, handmade recycled paper, and appropriate building materials. The scope of TARAGRAM is being extended to integrate other resources that can be made available with long-term renewability, by using local skills and through technology development. The project will aim to demonstrate the economic viability of Sustainable Production Systems, while ensuring maximization of products into the local economy.

Conclusion

Increasing the supply of building materials in India is achievable through a multi-pronged strategy which integrates energy efficiency, in relation to existing building materials and processes, with sustainable production systems for building material alternatives. The process can only be completed by ensuring eco-sensitive design and delivery processes which take user concerns into account and lead to the creation of sustainable livelihoods. The demand for housing can be met, while limiting energy and emissions to up to 50 per cent of the level that would be likely using conventional processes. This strategy would need a regional focus to take into account resource issues, livelihood requirements, and macroeconomic trends. A regional model for integrating these concerns has been evolved. It will be evaluated for its impacts on resources and livelihoods.

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Acknowledgements

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◆

Glossary

Adobe: Sun-dried clay bricks used without burning. They were the most popular walling materials for housing.

Autoclave blocks: Sand lime blocks manufactured by autoclaving. They are extremely energy-efficient, but can be manufactured in highly mechanized plants.

Burnt brick : Bricks manufactured from clay are burnt in household kilns or in more structured medium-scale kilns. The technology prevalent in India is the bull's trench kiln, and the fuel used for combustion is coal. They are the preferred walling materials.

Checkdam: A small water-harvesting structure built on streams and rivulets to ensure water retention, resulting in ground water charging and assured availability of ground water throughout the year.

Compressed earth blocks: Earth blocks compacted in a mechanical press with a preferred composition of 30-40 per cent coarse sand, 10-15 per cent clay, and silt and gravel. The strength can be improved through stabilization with lime, cement and synthetic binders.

Cylinder mould: A mechanized paper manufacturing process which employs continuous feeding of pulp and lifting of the paper. Suction is provided by a vacuum pump.

Ferro-cement: A highly versatile form of reinforced cement concrete, made from rich cement mortar (one part cement : two parts stone dust or sand) and wire mesh reinforcement. A common usage is ferro-cement channels for pre-fabricated roofing.

Gasifier: A reactor for partial combustion of woody or non-woody biomass. Producer gas is generated, which can be directly fed into a diesel-generating set. Up to 90 per cent of diesel can be replaced with the producer gas.

Gully plug: A soil conservation measure. A barrier is constructed using stone, masonry, or even biomass fencing. It not only checks the water velocity, but also leads to gradual recovery of soil through deposition.

Gyp board: Walling and roofing panels manufactured from phospho-gypsum, an industrial waste, by autoclaving.

Ipomia: A non-wood biomass which grows prolifically in streams, reducing their water-holding capacity. It emits fumes with a distinct odour when burnt directly and is therefore not used for fuel in rural areas.

Lantana: A weed species, *Lantana camara*, that grows plentifully on all wastelands. Its extermination is the first step in land regeneration. Lantana can be converted to char for clean domestic fuel. The stems are also used for basket weaving.

Micro-concrete roofing tiles: Carefully profiled concrete tiles (8-12 mm thick) for sloping roofs. They are manufactured on a vibrating table using a lean mix of concrete (one part cement : three parts of stone aggregate and sand)

Stone-cement blocks: Blocks made from a lean concrete mix comprising cement, sand, dust and aggregates in a ratio of 1 : 5 : 8. Stone is used as a filler. These blocks are either hand-moulded or vibrated on machines.

Vats: Hand-made paper made from pulp which is lifted through moulds fitted with sieves. This is a manual process, producing hand-crafted paper of limited size which can be customized according to end uses.

Vertical shaft brick kiln: A highly energy-efficient small-scale (4000 bricks/vertical shaft) brick manufacturing technology widely used in China. The energy savings are 25-30 per cent compared with the conventional bull's trench kiln commonly found in India.

The UNEP-sponsored Symposium on ESTs at Habitat II

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On 5 June 1996, during the Second World Conference on Human Settlements (Habitat II) in Istanbul, Turkey, the UNEP International Environmental Technology Centre (IETC) and GEC (Global Environment Center of Japan), a Japanese cooperating agency of IETC, sponsored a Symposium on Environmentally Sound Technologies. The Symposium included two panel discussions. The first panel discussed "soft" technologies, with a focus on those IETC is contributing to the Sustainable Cities Programme – environmental profiles, environmental technology assessment, and environmental risk assessment as important tools for environmental planning and management – and GEC's own technologies for environmental management. The panelists came from IETC, GEC, UNEP Industry and Environment (UNEP IE) in Paris, and USETI (the United States Environmental Training Institute). UNEP IE presented the EnTA (Environmental Technology Assessment) Programme and USETI discussed partnership-building arrangements for promoting "soft" ESTs.

The second panel addressed "hard" technologies, particularly municipal solid waste management, waste water treatment, and recycling. Organizations from four different regions of the world which have developed environmentally sound systems or products were invited to present their technologies. Representatives of the organizations made up the second panel.

The four selected ESTs were:

1. **BioTec2120 Solid Waste Management System**, developed by AG Environmental Group, Inc., Stamford, Connecticut, USA.
2. **Osaka City Solid Waste Management System**, developed by Osaka City, Japan.
3. **TgreenU Waste Water Treatment Plant**, developed by ENDA-Tiers Monde, Dakar, Senegal.
4. **BIOHOCH Reactor Waste Water Treatment Plant**, developed by UHDE, Dortmund, Germany.

These technologies were selected from different regions to demonstrate variations on similar technologies which address a common environmental problem under varying social, economic, cultural and geophysical conditions. The idea was to expose decision makers, policy makers and urban managers, particularly from local authorities, the industry sector and NGOs, to various ESTs and to give them the opportunity to scrutinize possible options for solutions to urban environmental problems in their localities.

The Osaka Solid Waste Management System, for instance, is a comprehensive municipal solid waste management scheme which focuses on waste reduction and technological innovations involving power generation through the waste incineration plant and heat provision for nearby communities. On the other hand, the BioTec2120 System is a high-tech composting system designed to work with sorted or unsorted municipal solid waste. It incorporates various pieces of equipment to dispose of non-biodegradables and unwanted non-recyclables, which is achieved automatically or with manual labor if so desired.

In the area of waste water management, UHDE's BIOHOCH reactor involves the use of aerobic biological waste water treatment plants which rely upon the natural processes taking place in rivers and other surface waters in an optimum way. It is a modern biological waste water treatment system which consists essentially of an almost cylindrical aeration section and a cone-shaped final clarifier, as opposed to conventional waste water treatment aeration basins with surface aerators. Its advantages over the conventional system are its high reliability, a freely accessible reactor, the fact that ground water is not endangered in any way, no odour emission because of a totally enclosed design, and minimum noise emission due to encapsulation of all noise sources.

A stark contrast to the high-tech UHDE system is a low-cost, community-based TgreenU waste water treatment plant developed by ENDA-Tiers Monde, an NGO in Dakar, Senegal. TgreenU is a purification plant, composed of a series of small reservoirs, which uses water lettuce as a natural purifier. It is not a new idea, but a revival of a traditional practice used in Sudan for over a thousand years.

IETC encouraged local authorities to participate in the Symposium, since cities need environmentally sound technologies (ESTs) to be sustainable. ESTs need not be high-tech or expensive to be useful. What matters most is that technologies which address urban environmental problems are not harmful to humans and the ecosystem, and that local executives are aware that the sustainable development of their cities depends, among other things, upon an understanding of ESTs, their proper application and management, and above all on the knowledge that ESTs exist and are available.

The particular technologies selected for the Symposium did not represent all the solid waste management or waste water treatment technologies IETC would like to promote. Other technologies have been developed in other countries. The Symposium could only show a sampling of available technologies whose owners were willing to share information.

The Habitat II Conference and the construction sector

United Nations Centre for Human Settlements (HABITAT), PO Box 30030, Nairobi, Kenya

Introduction

The construction industry is a major contributor to socio-economic development in every country. It is also a major source of environmental stress and a significant consumer of the planet's non-renewable resources. The highly multi-sectoral and dispersed character of the construction industry makes it difficult to monitor, in quantifiable terms, the environmental degradation it causes. However, conflicts between sectorial activities and their deterioration of the physical environment are already evident in many countries. Increased awareness and knowledge of the implications of environmental stress caused by the construction industry have resulted in some action being taken in industrialized countries, but developing countries have made very little progress in arresting this situation.

The conference

Recognizing the importance of the construction industry in delivering adequate housing and infrastructure facilities for millions of poor and low-income people worldwide, the United Nations Conference on Human Settlements (Habitat II) held in Istanbul, Turkey, in June 1996 underscored, *inter alia*, the direct relationship between the construction sector and Adequate Shelter for All by including "Improving planning, design, construction, maintenance and rehabilitation" as a distinct action area in the "Habitat Agenda". The Conference, while emphasizing the need for increased and environmentally sound construction, adopted a set of recommendations/actions to be implemented by Governments and all other stake-holders so as to improve the performance of the sector globally. The section on construction which is part of Chapter IV – "Global Plan of Action: Strategies for Implementation" – and which appears under the theme "Adequate Shelter for All" is given below.

[Numbers of paragraphs and text have been taken from the advance and unedited version of Habitat Agenda dated 3 July 1996.]

(f) Improving planning, design, construction, maintenance and rehabilitation

85. With rapid urbanization, population growth and industrialization, the skills, materials and financing for the planning, design, construction, maintenance, and rehabilitation of housing, infrastructure and other facilities are often not available or are of inferior quality. Public policy and private investment should, together, facilitate an adequate supply of cost-effective building materials, construction technology and bridging finance to avoid the bottlenecks and distortions that inhibit the development of local and national economies. By improving the quality and reducing the cost of production, housing and other structures will last longer, be better protected against disasters, and be affordable to low-income populations and accessible to persons with disabilities, which will provide a better living environment. The potential for job creation and other positive external socio-economic impacts of the construction industry should be harnessed; its activity should be brought into harmony with the environment, and its contribution to overall economic growth should be exploited, all to the advantage of society at large. Institutional support should also be provided in the form of industrial standards and quality control, with particular attention to energy efficiency, health, accessibility, and consumer safety and protection.

86. Meeting the actual needs of individuals, families and their communities cannot be achieved by looking at shelter in isolation. Provision of adequate social services and facilities, improving and rationalizing urban planning and shelter design to cope firmly with the actual needs of communities, as well as provision of technical and other relevant assistance to the inhabitants of unplanned settlements are essential for the improvement of living conditions.

Actions

87. To respond effectively to the requirements for appropriate planning, design, construction, maintenance and rehabilitation of shelter, infrastructure and other facilities, Governments at the appropriate levels should:

(a) Encourage and support research and studies to promote and develop indigenous planning and design techniques, norms and standards to match the actual needs of local communities;

(b) Encourage public participation in assessing real user needs, especially gender needs, as an integrated action of the planning and design process;

(c) Encourage the exchange of regional and international experience of best practices and facilitate the transfer of planning, design and construction techniques;

(d) Strengthen the capacities of training institutions and non-governmental organizations to increase and diversify the supply of skilled workers in construction and promote apprenticeship training, particularly for women;

(e) Make use of contracts with community-based organizations and, where applicable, the informal sector for the planning, design, construction, maintenance and rehabilitation of housing and local services, especially in low-income settlements, with an emphasis on enhancing the participation and, thus, short- and long-term gains of local communities;

(f) Strengthen the capacity of both public and private sectors for infrastructure delivery through cost-effective, employment-intensive methods, where appropriate, thereby optimizing the impact on the creation of employment;

(g) Promote research, exchange of information and capacity-building with respect to affordable and technically and environmentally sound building, maintenance and rehabilitation technologies;

(h) Provide incentives for engineers, architects, planners and contractors and their clients to design and build accessible energy-efficient structures and facilities by using locally available resources and to reduce energy consumption in buildings in use;

(i) Provide training to professionals and practitioners in the construction and development sector to update their skills and knowledge in order to promote the development of shelter programmes that serve the interests and needs of women, persons with disabilities and disadvantaged groups and that ensure their participation at all stages of the shelter development process;

(j) Adopt and ensure the enforcement of appropriate standards relating to planning, design, construction, maintenance and rehabilitation;

(k) Support private-sector initiatives to provide bridging loans to builders at reasonable interest rates;

(l) Support professional groups in offering technical assistance in planning, design, construction, maintenance, rehabilitation and management to community-based organizations, non-governmental organizations and others engaged in self-help and community-based development;

(m) Strengthen and make more transparent government regulatory and inspection systems;

(n) Join with professional societies to review and revise building codes and regulations based on current standards of engineering, building and planning practices, local conditions and ease of administration, and adopt performance standards, as appropriate;

(o) Support non-governmental organizations and other groups to ensure full and equal participation of women and persons with disabilities in the planning, design and construction of houses to suit their specific individual and family requirements.

88. To promote and support an adequate supply of locally produced, environmentally sound, affordable and durable basic building materials, Governments at the appropriate levels, in cooperation with all other interested parties, should:

(a) Where appropriate, encourage and support the establishment and expansion of environmentally sound, small-scale, local building materials industries and the expansion of their production and commercialization through, *inter alia*, legal and fiscal incentives and the provision of credit, research and development, and information;

(b) As required, provide policies and guidelines to facilitate fair market competition for building materials with enhanced participation of local interested parties and establish a public mechanism to enforce them;

(c) Promote information exchange and the flow of appropriate environmentally sound, affordable and accessible building technologies and facilitate the transfer of technology;

(d) With adequate attention to safety needs, reformulate and adopt building standards and by-laws, where appropriate, to promote and permit the use of low-cost building materials in housing schemes, and use such materials in public construction works;

(e) Where appropriate, promote partnerships with the private sector and non-governmental organizations to create mechanisms for the commercial production and distribution of basic building materials for self-help construction programmes;

(f) Evaluate on a regular basis the progress made in the pursuit of the above objectives.

89. To enhance the local capacity for environmentally sound production of building materials and construction techniques, Governments at the appropriate levels, including local authorities, in cooperation with all interested parties, should:

(a) Intensify and support research efforts to find substitutes for or optimize the use of non-renewable resources and to reduce their polluting effects, paying special attention to recycling, re-use of waste materials and increased reforestation;

(b) Encourage and promote the application of low-energy, environmentally sound and safe manufacturing technologies backed by appropriate norms and effective regulatory measures;

(c) Adopt mining and quarrying policies and practices that ensure minimum damage to the environment.

Environmentally sound practices in the construction sector: progress with on-site green techniques (OGTs) in Japan

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Abstract

A survey of On-Site Green Techniques (OGTs) covering manufacturing and construction companies in Japan was conducted in 1994-95. OGTs are defined by the authors as techniques which result from the ingenuity and creativity of people working on-site, ranging from improvements in equipment and processes to the use of simple new ways to control and reuse waste materials. Eighty-two OGTs were identified in a report published early this year. Eight of them, developed by construction companies, are described in this article. Technical information on these and other OGTs will be provided on the WWW site, ***http://www. unep.or.jp/gec/****.*

Résumé

Une étude sur les OGT (techniques écologiques à employer sur place), couvrant les industries de fabrication et les entreprises de la construction au Japon, a été effectuée en 1994-1995. Les OGT sont définies par les auteurs de l'article comme des techniques issues de l'ingéniosité et de la créativité des personnes travaillant dans ces entreprises et vont de l'amélioration du matériel et des processus à de nouvelles façons simples de contrôler la production de déchets et de réutiliser ceux-ci. Quatre-vingt deux OGT figurent ainsi dans un rapport publié en début d'année. Huit d'entre elles, mises au point par des entreprises du bâtiment, font l'objet d'une description. Les informations techniques portant sur les OGT seront accessibles sur le site WWW, ***http://www.unep.or.jp/gec/****.*

Resumen

Entre 1994 y 1995, se realizó una encuesta sobre las Técnicas Verdes in situ *(OGT), que cubre las sociedades de fabricación y construcción en Japón, se realizó en 1994-95. Los autores definen las OGT como técnicas que resultan del ingenio y creatividad de la gente que trabaja* in situ*, que van desde los avances en el equipo y los procesos hasta la adopción de formas de control y reutilización de materiales de desecho novedosas y más sencillas. En un informe publicado a comienzos de este año se identificaron ochenta y dos OGT. En este artículo, se describen ocho de ellas, desarrolladas por sociedades constructoras. La información técnica sobre estas y otras OGT estará disponible en el WWW site,* ***http://www.unep.or.jp/gec/****.*

Introduction

As corporate awareness of the importance of environmental issues continues to grow, increasing pressure is being exerted on managers and staff, on-site and at the factory, to adopt new practices and techniques which conserve rather than damage the environment. It can therefore be assumed that, over the years, a great many basic environmental protection and conservation measures have been developed at manufacturing facilities and on construction sites. Although rarely documented, these techniques represent pragmatic ad hoc responses to particular environmental problems faced on a day-to-day basis. They demonstrate innovative approaches based on ingenuity and flexibility. The Global Environment Centre (GEC) describes these measures as On-Site Green Techniques (OGTs). Aware that existing literature covering this topic may be limited, it initiated a survey on OGTs in manufacturing and construction industries beginning in December 1994. The results have been compiled in a report, *Survey of On-site Green Technique in Japan*, the Japanese version of which was published in January 1996. This article presents the survey findings as related to the construction sector. The English version will be published in May and will be made accessible via the GEC homepage (http//www.unep.or.jp).

Survey of on-site green techniques

Definition of OGTs

Waste materials, waste liquids, exhaust gases, noise and vibration are generated as a result of production activities and construction work. Reduction and elimination of these negative environmental side-effects can be attained through measures ranging from front-end design to on-site mitigation. The survey undertaken by GEC sought specifically to identify those techniques which require only limited capital investment and which develop out of the ingenuity and creativity of people working on-site. These OGTs vary in scope from improvements in equipment and processes, through monitoring, inspection and check-up techniques, to the installation of simple yet efficient devices to control and reuse the waste materials generated.

Approach to the survey

Purpose. In the past, the transfer of environmentally sound technologies (ESTs) to developing countries has often focused on the transfer of sophisticated environmental preservation techniques from industrially advanced countries, with soft and indigenous technologies often overlooked or ignored. Chapter 34 of Agenda 21, which emerged out of the 1992 Earth Summit, made a significant contribution towards redressing the balance. It specifically called for the management of technological change in order to bring about the transition to more sustainable forms of development. While the grand objectives of Agenda 21 are recognized as essential, they need to be supported by practical actions taken by individuals on the ground. In this context, there is a possibility that small-scale and basic techniques, which may be more readily understandable and which could take root in the receiving countries relatively easily, may be overlooked. The framework for the transfer of these techniques remains sketchy, as they have often only been utilized within a single corporation and in many instances may not even have been shared with other corporations in the same country.

In this context, GEC embarked upon the survey of OGTs with two main objectives:

- to collect and organize technical information concerning on-site environmental preservation efforts by various corporations, and to offer this information widely to developing countries;
- to collect and organize information on corporate attitudes and organizational systems which make full use of the on-site techniques and technology.

Questionnaire survey. A questionnaire survey was conducted in order to obtain information on the types of OGTs currently being adopted by corporations in Japan. Over 700 questionnaire forms were sent by mail to corporations in a variety of industrial sectors including construction, foods, pulp and paper, chemicals, machinery, electrical machinery, etc. Forty-two companies answered the questionnaire, including seven construction companies. From these answers, 82 OGTs were identified.

Follow-up meetings. Follow-up meetings were conducted with 13 companies (at 15 sites), including one construction company, in order to confirm the technical information given on the returned questionnaires and obtain specific examples with regard to the three points listed below:

- information on OGTs other than that given on the questionnaires;
- ideas for promoting continued use of OGTs;
- ideas on OGT information collection systems.

The results of the questionnaire survey and follow-up meetings are summarized briefly in this article and, more extensively, in *Survey of On-site Green Technique in Japan.*

Figure 1
Floor panel concrete for mould-less method effects

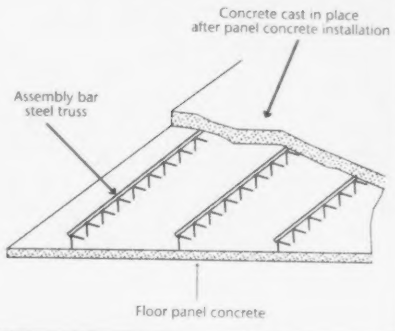
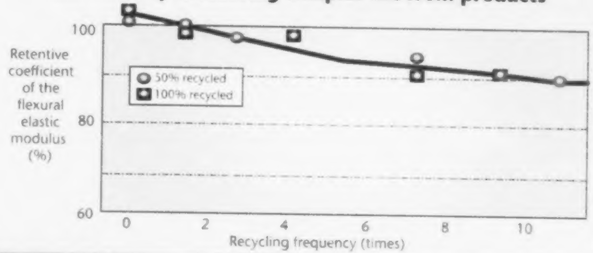


Figure 2
The intensity of the recycled mould – the value by measuring samples cut from products



Environmental activities of the construction industry

The environmental activities of the construction industry are particularly important, since in 1994 it represented approximately 17 per cent of Japan's Gross Domestic Product (GDP) and 10 per cent of the total workforce (Ministry of Construction, 1994). It is widely recognized that construction imposes significant impacts on the environment. For example, in 1985 it was estimated that energy consumption associated with construction activity, from the production of construction materials to the actual construction work, represented 20 per cent of Japan's total energy use (Ishikawa, 1992). Industrial waste generated from construction sites, estimated at 77,106,000 tonnes, amounted to 19 per cent of total industrial waste in fiscal year 1991. Fifty-eight per cent of this waste is disposed of at landfill sites (Ministry of Public Health and Welfare, 1994).

In the field of environmental management, a major impetus for the activities of construction companies in Japan came towards the end of the 1980s when global environmental problems took on renewed importance. **Table 1** presents some examples of the types of measures construction companies began to implement at that time. Although many of these companies, especially the large-scale ones, had established a division to deal specifically with environmental issues in the 1970s, the actual scope of these divisions was enlarged in the late 1980s to include global environmental considerations related to global warming, ozone layer depletion, and deforestation. In addition, many companies also set out their environmental policies in the form of environmental charters or action plans (Takanaka Corporation, 1992). These policies were supported by manuals developed to instruct construction site staff on appropriate approaches to environmental protection (Taisei Corporation, 1993) and by environmental education activities targeted at all employees.

Table 1
Environmental activities in construction companies

Item	Environmental Activities
General management	Establishment of an environmental charter or action plan. Strengthening of the environment division. Development of manuals for environmental activities. Implementation of environmental education of employees.
Project stage	
Planning	Implementation of Environmental Impact Assessment. Development of an environmental plan for the project.
Design	Design of building with low load on environment. Environmental factors taken into consideration.
Construction	Decrease amount of generated solid waste. Reuse generated solid waste. Adopt environmentally sound technology for construction.
Maintenance	No information available (considered at the planning and design stage).
Research and development	Develop technologies for waste water treatment, solid waste treatment and energy saving. Develop modelling and simulation techniques.

The questionnaire survey and follow-up meetings produced information on OGTs currently being applied by construction companies and details of their general activities and policies with respect to environmental issues. Their corporate brochures included statements recognizing the need to take environmental preservation measures into account at each stage of construction from planning, design, and construction to maintenance. At the planning stage, environmental impact assessment (EIA) should be undertaken for large-scale construction. Various types of environmental plans need to be developed to preserve the natural environment and reduce waste generated at the construction site. At the design stage, measures should be taken to include energy-saving technologies and intermediate water supply systems in order to reduce total water consumption. The construction stage, where most OGTs are likely to be developed, is discussed in the next section. With respect to the actual maintenance of the facility, once constructed, no specific techniques were identified through the GEC survey. However, as mentioned in Table 1, the reduction of impacts on the environment during operation and maintenance are primary considerations at the planning and design stages. With respect to R & D, the emphasis is on the development of ESTs to be used in construction and on simulation techniques which can be used in EIA.

On-site green techniques from construction companies

Typical examples of OGTs identified through the survey are described below, together with the results of the follow-up meeting.

A concrete construction method which does not require moulds

Objectives: Develop and promote a construction method using PC (panel concrete), which does not require moulds for pouring concrete, in order to reduce the amount of waste generated at the construction site and control the use of moulds made from tropical wood.

Description: Components of a building such as floors, walls, columns, stairs, girders and beams are manufactured as panel concrete. These panel concrete components are assembled into one structure using cast-in-place concrete. The panel concrete components also function as moulds for the cast-in-place concrete (**Figure 1**).

A plastic mould method

Objectives: The typical veneer board mould requires wood from tropical broadleaf (lauan) and coniferous trees. Using a plastic mould reduces the volume of the trees cut down. The plastic moulds can be recycled, thus reducing construction waste.

Description: The panel consists of a rib which functions as sheathing and balks, so that cross-

Figure 3
Recycling system for soil from the slurry shield method

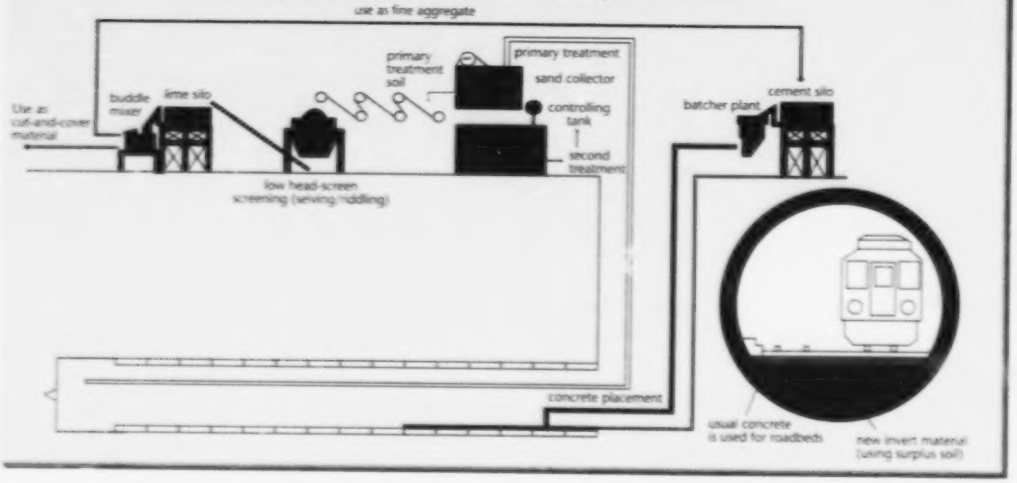
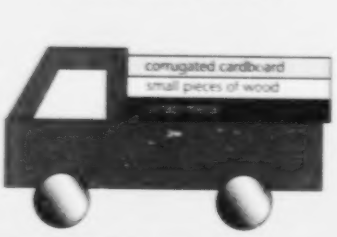

use as fine aggregate
Use as cut-and-cover material
buddle mixer
lime silo
primary treatment soil
primary treatment
sand collector
controlling tank
second treatment
low head-screen screening (seiving/riddling)
batcher plant
cement silo
concrete placement
usual concrete is used for roadbeds
new invert material (using surplus soil)

Figure 4
The waste on pallets loaded on the truck separately


corrugated cardboard
small pieces of wood

pieces are unnecessary. It is lightweight and easy to use. Moreover, moulds are collected after use and recycled (**Figure 2**).

Effects: Dispensing with the crosspieces makes the work more efficient. Reductions in the volume of tropical wood used and of industrial waste ensue. The mould is easy to handle because of its light weight.

Ideas for continuous application: It is necessary to protect the mould from welding sparks, since it is easily affected by heat. The mould should not be shaken or dropped, as this can affect its usability. The mould is cut using a chain saw for plastic.

Recycling of primary treatment soil using the slurry shield method

Objectives: Soil, derived through the slurry shield method, is recycled and contributes to environmental protection and to construction cost reductions (**Figure 3**).

Description: Sand made available as aggregate is separated from the earth and sand accumulated using the method. By kneading this sand with cement base coagulant, the sand is recycled.

Effects: Surplus soil accumulated by drilling in the shield construction can be used effectively, resulting in reductions in delivery and disposal costs of the surplus soil. However, on-site experience shows that facility costs and operating costs may exceed previous purchasing costs for ready-mixed concrete by about 4 per cent. If the company recycles more products, to be used in more than one construction section, this method can be cost-effective.

Ideas for continuous application: The establishment of an execution method and a quality control system is required. Application to the cut-and-cover method, and to secondary lining concrete, will be studied.

Transport of different kinds of construction waste together

Objectives: In construction fieids waste is separated into eight categories according to standard segregation rules of the Building Constructors Society, which decided on the design of the identification placards shown in **Figure 5**. These categories are combustibles, non-combustibles, corrugated cardboard, small pieces of wood for construction, scrap metal, concrete, garbage, and empty cans. The volume of waste varies by type. Generally there is not room for much waste at the site. Consequently, when removing waste from the site, in order to reduce transportation costs it is necessary to load various types of wastes together on the trucks.

Description: Pallets for the waste separation are placed on-site. The waste on the pallets is loaded on the truck bed separately (like a sandwich, as shown in **Figure 4**). Every pallet must be bound tightly before loading.

Effects: This OGT is effective in rationalizing the transport of waste.

Ideas for continuous application: Truck drivers should be made aware of this OGT.

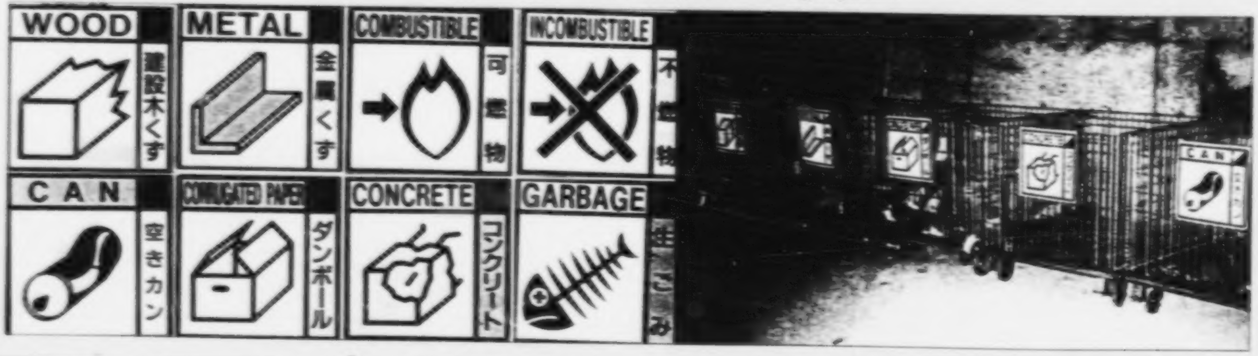
Separate storage for general waste, industrial waste, and corrugated cardboard found on construction sites

Objectives: In the past, general waste, industrial waste and corrugated cardboard (for packing) found on construction sites have been stored in one place. It was difficult to identify the contents of the waste pile, and the disposal costs were high.

Description: Waste materials are placed in containers such that the waste materials inside can be readily recognized.

Effects: Separate storage helps improve the site environment. Costs of disposal are reduced. Some items suitable for recycling can be separated on-site.

Figure 5
The identification placards and separate storage system

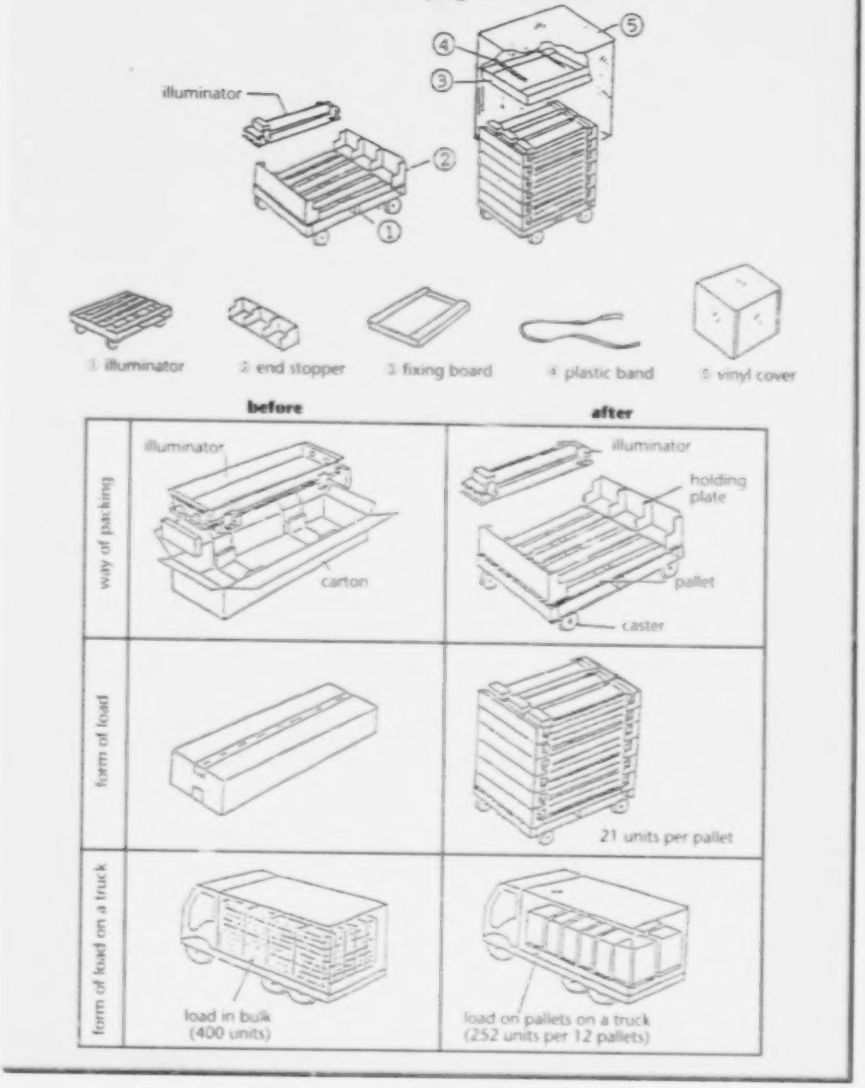

WOOD
建設木くず
METAL
金属くず
COMBUSTIBLE
可燃物
INCOMBUSTIBLE
不燃物
CAN
空きカン
CORRUGATED PAPER
ダンボール
CONCRETE
コンクリート
GARBAGE
生ごみ
CAN

Ideas for continuous application: Posters are put up to inform the contractors on construction sites about the separate storage of waste products.

Using pallets for carrying illuminators to construction fields

Objectives: The illuminators are generally wrapped in paper or vinyl sheets and put in corrugated cardboard boxes, so that they are not stained or rubbed. This creates a lot of waste packing materials on the construction sites.
Description: The pallets for carrying the illuminators developed as in **Figure 6** replace the usual packing materials. After the pallets are carried to the site, they can be brought back and reused. The distinction between before and after the adoption of the pallets is also shown in Figure 6.
Effects: Waste packing material is reduced to zero. The operation to pack the products is more simple. The labour to unpack and dispose of the waste carton is reduced. Loading and unloading a truck and carrying the products in an elevator has been made easier.
Ideas for continuous application: This rack is made to carry various types of apparatus, so that it can be used flexibly.

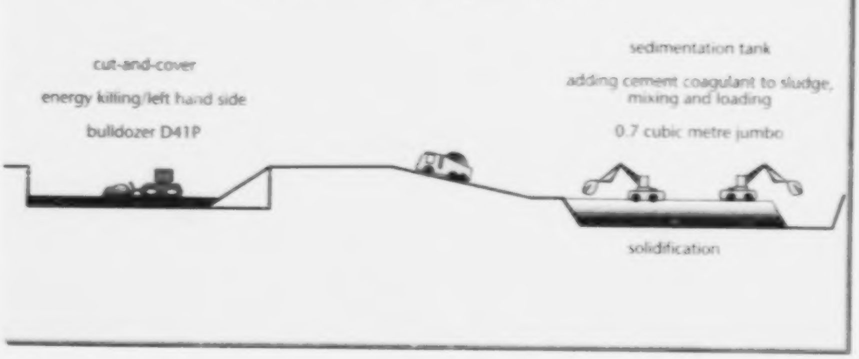
Figure 6
Pallet for carrying illuminators


illuminator
①
②
③
④
⑤
① illuminator
② end stopper
③ fixing board
④ plastic band
⑤ vinyl cover
before
after
way of packing
illuminator
carton
illuminator
holding plate
pallet
caster
form of load
21 units per pallet
form of load on a truck
load in bulk (400 units)
load on pallets on a truck (252 units per 12 pallets)

Recycling sludge in a sedimentation tank for treating turbid water in order to cut-and-cover material in the company's plant

Objectives or Reasons: It was very expensive to dispose of a great deal of sludge as industrial waste.
Description: Although the sludge is inorganic, its moisture content is high (about 90 per cent). This fluidity makes it unsuitable for cut-and-cover. The sludge needs to be solidified if it is to be used as cut-and-cover material (**Figure 7**).
Effects. The costs of disposing industrial waste are reduced by four thousand yen per cubic metre (from ten thousand to six thousand yen).
Ideas for Continuous Application: The company scrutinizes execution procedure, such as the method of mixing the sludge and coagulant and the amount of the sludge disposed per batch.

Figure 7
The sedimentation sludge reuse system


cut-and-cover
energy killing/left hand side
bulldozer D41P
sedimentation tank
adding cement coagulant to sludge, mixing and loading
0.7 cubic metre jumbo
solidification

Neutralization equipment for waste water used in casting concrete at a factory

Objectives: The residue of concrete (which is strongly alkaline) generated at a construction site should be neutralized.
Description: A temporary plant is created at a large-scale construction site (**Figure 8**).
Effects: The residue of concrete generated in long-term construction (concrete construction) can be treated appropriately.

Reduction of waste in cooperation with the material supplier

A great quantity of material is brought onto a construction site, generating a huge amount of used containers and wrapping materials. A company asked the supplier for its cooperation in reducing the amount of wrapping.

The method of packing each item in a corrugated cardboard box was switched to the repeated use of a carrier rack developed by the construction company. In addition, the parts of lighting fixtures were brought in for assembly on-site in the past. But now the material supplier assembled the fixtures in the factory and transported the finished products to the site, using a "finished product carrier pallet" developed by the company. Thus, packing in a traditional sense was no longer necessary, resulting in substantial reduction of packing containers and wrapping materials (**Figure 9**).

There was another problem with boards. Standard-size boards had been brought to the site and processed there, resulting in a great number of odd pieces. To solve this problem, the working drawings were prepared at an early stage so that building materials could be ordered in the required size.

Thus, processing on the site was kept to a minimum, reducing the amount of waste materials generated.

Every office of the company (both the head and branches) has an ad hoc committee on proper industrial waste management. Under that committee, another special committee has been organized jointly with other locally affiliated companies. Thus, a system has been established to promote activities in cooperation with other companies.

Summary

This article has provided an insight into some of the everyday activities of construction companies with respect to environmental conservation. It is clear that corporate entities in Japan cannot carry on their normal business without taking environmental issues into account. From the survey, it is also clear that large construction companies have considerable experience and expertise in dealing with environmental problems and are willing to share this information with GEC. The next steps would be for GEC to continue with the survey and to disseminate the findings more extensively through a range of media, including a database accessible via the Internet

GEC would like to establish some form of two-way communication between the developers of OGTs and potential users, to understand the extent to which these techniques can be effectively used elsewhere. It is hoped that, by starting this transfer process, GEC will trigger the increased transmission of OGTs around the world and that people will further develop the OGTs provided ingeniously and creatively.

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◆

Figure 8
The temporary naturalization equipment

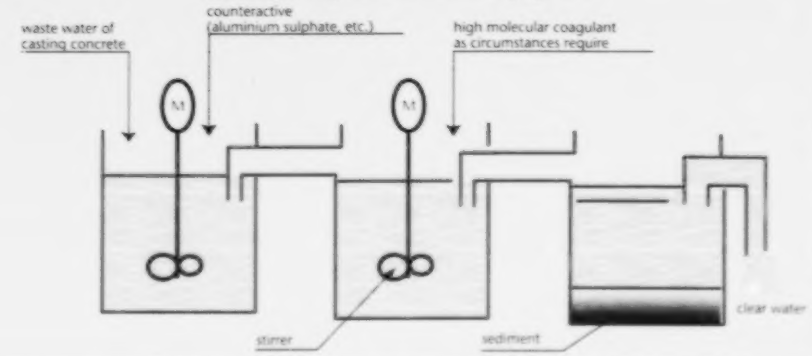
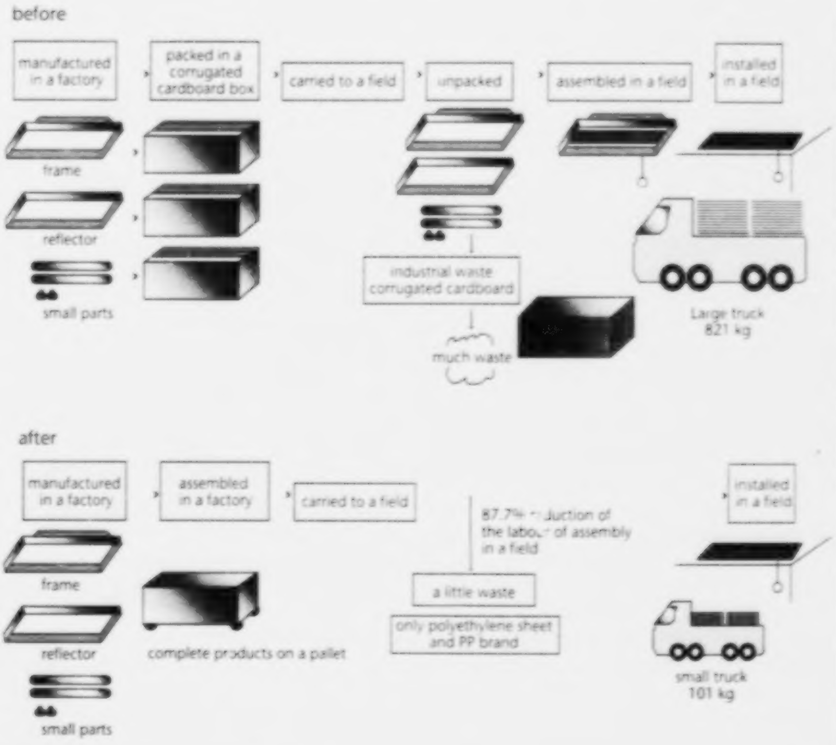

counteractive
(aluminium sulphate, etc.)
waste water of
casting concrete
high molecular coagulant
as circumstances require
M
M
clear water
stirrer
sediment

Figure 9
The finished product carrier pallet system


before
manufactured
in a factory
packed in a
corrugated
cardboard box
carried to a field
unpacked
assembled in a field
installed
in a field
frame
reflector
small parts
industrial waste
corrugated cardboard
much waste
Large truck
821 kg
after
manufactured
in a factory
assembled
in a factory
carried to a field
87.7% reduction of
the labour of assembly
in a field
installed
in a field
frame
reflector
small parts
complete products on a pallet
a little waste
only polyethylene sheet
and PP brand
small truck
101 kg

Réduction et gestion des déchets de chantier en France

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Résumé

Réduire l'impact des chantiers de construction et de démolition sur l'environnement et les quantités de déchets ou améliorer leur valorisation ne peut être une démarche isolée. Cela doit faire partie d'une réflexion d'ensemble sur la qualité dès la phase « études » d'un projet ; elle doit se poursuivre à l'étape de la conception du projet, lors de la préparation du chantier et pendant la phase d'exécution des travaux. L'article présente quelques exemples de solutions mises en avant pour la gestion des déchets de construction sur des chantiers expérimentaux lancés par le Plan Construction et Architecture (PCA) et l'Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME) en France.

Abstract

Reducing the impact of building sites and the waste material they generate on the environment, or enhancing the value of such waste materials, are challenges which cannot be tackled in isolation. Instead, they must be looked at together, in terms of quality, immediately the project hits the drawing board, beginning at the project design stage and working right through to the final execution of the works. This article presents a number of examples of solutions put forward for managing waste materials from experimental construction sites in France.

Resumen

Reducir el impacto de las obras de construcción sobre el medio ambiente y las cantidades de residuos o mejorar su valorización, no puede ser un procedimiento aislado. Debe formar parte de una reflexión de conjunto sobre la calidad desde el estudio de un proyecto; proseguir en la etapa del diseño del proyecto, en la preparación de la obra y en la fase de ejecución de los trabajos. El artículo presenta algunos ejemplos de soluciones planteadas para la gestión de los residuos en obras experimentales en Francia.

1. Introduction

Réduire les nuisances de chantier répond à deux objectifs :

- préserver des ressources naturelles ou réduire l'impact des chantiers sur l'environnement; et
- réduire les gênes pour les usagers (extérieurs ou intérieurs au chantier) : mitoyens, passants, automobilistes, occupants (réhabilitation en présence des occupants), mais aussi les professionnels du chantier.

Réduire les quantités de déchets de chantier ou améliorer leur valorisation ne peut être une démarche isolée : cela doit faire partie d'une réflexion d'ensemble.

Différentes questions doivent être étudiées avant le démarrage du chantier, en particulier :

- la planification de la mise en oeuvre des produits de façon à limiter les chutes donc la production des déchets (calepinage) ;
- les réservations à prévoir sur les différents planchers pour le passage des gaines et conduits ;
- le nombre de bennes destinées à collecter les déchets, leur type et leur emplacement selon des différentes phases du chantier ;
- l'analyse des coûts des différentes filières de traitement des déchets (tri sur le chantier ou sous-traitance aux professionnels de la gestion des déchets);
- l'organisation du chantier et les dispositions contractuelles (contrats de sous-traitance, etc.).

2. Exemples de solutions

Nous développons ci-après quelques exemples de solutions expérimentées en France dans la constructin neuve de logements sociaux.

◆ Le calepinage

A partir du moment où la planification est faite, une réflexion devient possible entre le concepteur et l'entreprise pour calepiner de manière à limiter les chutes et optimiser différentes méthodes de construction. Cette démarche garantit une réduction des pertes de matière et de temps pour les différents corps de métier, par exemple les installateurs de cloisons et les poseurs de revêtement.

◆ Les réservations

La réservation sur les différents planchers pour la passage des gaines peut s'effectuer par la pose d'une caisse en bois avant coulage du béton, afin d'éviter les déchets habituels de polystyrène. Cette caisse peut être réutilisée au cours du chantier. Il faut prévoir avec ce procédé un couvercle pour boucher les trous afin de garantir la sécurité du personnel de chantier. Il faut également veiller à la bonne dimension de cette caisse (**figure 1**). En effet, la réduction des nuisances sera d'autant plus réussie s'il n'y a pas de reprise au marteau piqueur en fin de chantier.

Pour les gros chantiers, il peut être astucieux de faire les réservations avec un cylindre de type gaine en zinc, avec un couvercle adapté (**figure 2**). Ce matériel, plus cher, nécessite d'être amorti sur un nombre suffisant de logements. Peut-on imaginer une dimension standard ne dépendant pas des chantiers ? Ce n'est pas chose facile mais des possibilités existent dans un produit répétitif comme dans le logement social par exemple. Une autre solution peut être de faire les réservations en deux temps : d'abord la réservation maximale, puis le coulage du béton avec des réservations précises.

◆ Le tri des déchets

Le premier choix à faire est de savoir jusqu'à quel point l'entreprise trie à la source, et à partir de quel point il faut sous-traiter à une entreprise spécialisée. Le critère déterminant est la limite de tri que l'on peut demander au personnel de chantier. Les grandes familles de matériaux sont facilement comprises, grâce à des pictogrammes simples apposés sur les bennes (**figure 3**). En revanche, il est difficile de distinguer les différents types de matériaux dans une même famille : films plastique de différents types de plastique, bois traités et bois non traités par exemple.

Le tri à la source est nécessaire, car il évite la présence de matériaux inertes (béton, briques, etc.) dans les déchets industriels banals (plastique, papier, bois non traité, etc.). Les matériaux inertes font chuter la qualité de ces déchets. Il est également bien moins coûteux de faire ce tri à la source que lorsque les déchets arrivent mélangés dans un centre de tri.

Sur le chantier, on peut donc prévoir différentes bennes , selon la présence ou non de filières locales de valorisation des déchets : métaux, cartons non souillés, plâtre non souillé, déchets spéciaux, etc.

La première contrainte déterminant le nombre de bennes à mettre en place, c'est le terrain disponible. Il faut également que les bennes soient facilement accessibles pour les camions venant de l'extérieur et pour les ouvriers du chantier.

Néanmoins, il est illusoire de penser que l'on pourra trier tous les déchets de chantier. Au cours de l'intervention des corps de métier secondaires (menuisiers, peintres, etc.) le chantier produit des petites quantités de déchets en mélange qu'il est très difficile de trier (résultat de nettoyages, balayage,...). Il est souhaitable de prévoir une benne pour recevoir les déchets de classe II (déchets industriels banals tels que cartons, papiers, bois non traités, plastiques, etc.), afin d'éviter qu'ils ne soient déposés dans les bennes de déchets triés et ne viennent les contaminer.

Figure 1
Réservation sous forme de caisse en bois, posée avant coulage du béton afin d'éviter les déchets habituels de polystyrène

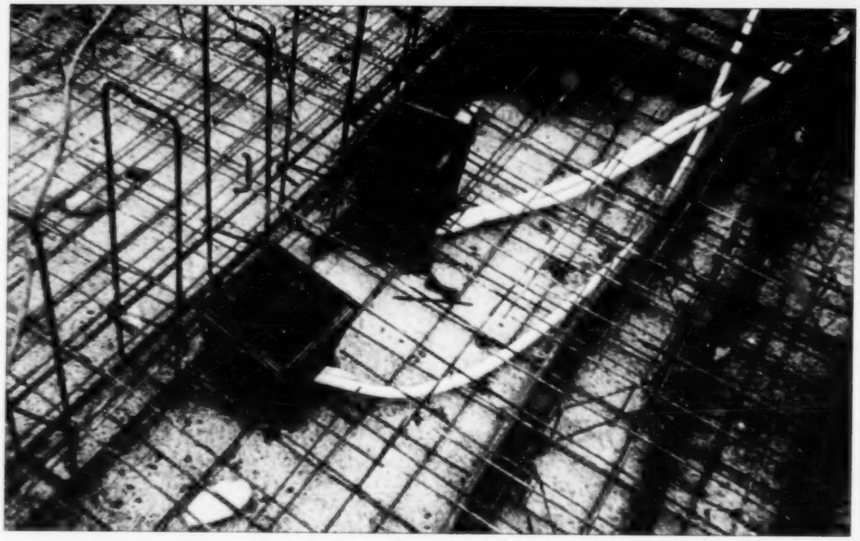


Figure 2
Réservation sous forme de cylindre métallique intégré dans la dalle avec couvercle de sécurité, sans déchets

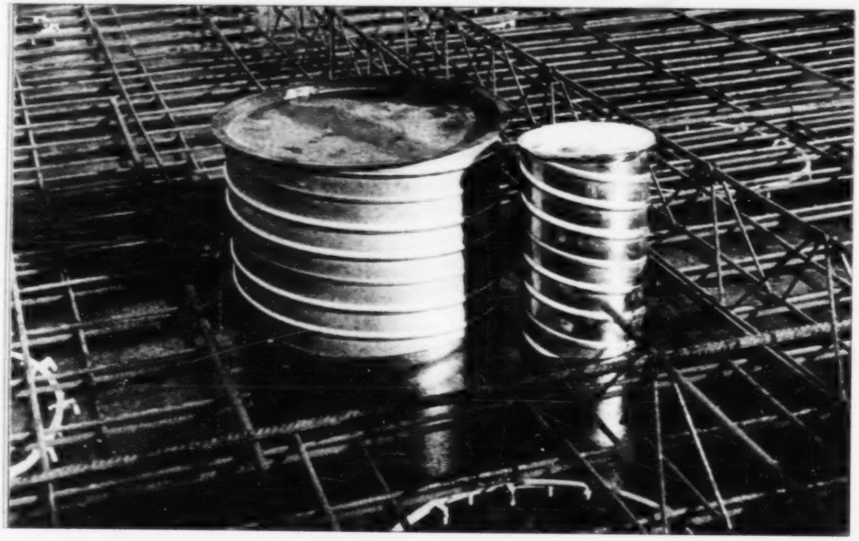
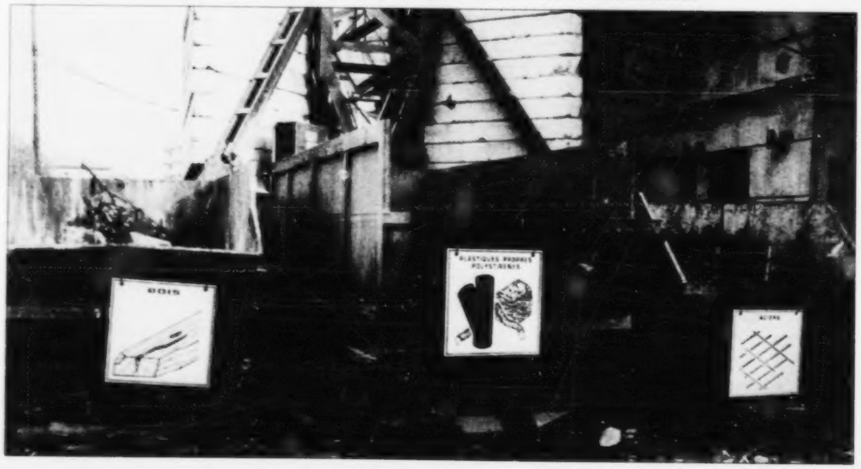


Figure 3
Tri des déchets sur le chantier dans différentes bennes



3. L'organisation du chantier et les dispositions contractuelles

Le choix de désigner un responsable de la gestion des déchets de chantier est tentant. Cependant il n'est pas facile de donner des règles uniformes pour tous les chantiers.

◆ Les chantiers réalisés en entreprise générale

C'est le cas le plus facile. Il revient au maître d'ouvrage (donneur d'ordre) de spécifier que l'entreprise générale est responsable de la gestion des déchets sur toute la durée du chantier et doit assumer également la responsabilité de l'acheminement des déchets dans les différentes filières de valorisation. Le contrat peut spécifier que l'entreprise devra disposer plusieurs bennes et former ses ouvriers et ceux du second oeuvre, etc. Il va sans dire que de telles dispositions impliquent que le maître d'ouvrage laisse la possibilité technique de leur réalisation : emprise au sol et terrain disponible, temps de préparation de chantier notamment.

L'entreprise générale inclut cette prestation dans son prix global. On peut également imaginer que le choix de l'entreprise s'effectue par le maître d'ouvrage en fonction de critères environnementaux et notamment de réponses aux exigences de traitement des déchets. Cela implique une approche du marché prenant en compte plusieurs critères et pas uniquement le prix.

Au niveau de l'entreprise générale, une démarche est nécessaire envers ses sous-traitants : démarche contractuelle d'abord (clauses inscrites dans les contrats de sous-traitance), démarche de formation et d'information du personnel de chantier y compris les corps de métier secondaires, démarche d'encadrement du chantier, même après la fin du gros-oeuvre.

◆ Les chantiers en corps de métier séparés

Il est plus difficile de confier la gestion des déchets au gestionnaire du compte prorata[1] ou au mandataire du groupement des entreprises (souvent le gros oeuvre), qui n'est pas forcément présent pendant toute la durée du chantier. Par ailleurs, gérer les déchets en fonction de la part de marché de chaque corps de métier dans le contrat global ne tient compte ni de la qualité ni de la quantité de déchets produite par chacun et déresponsabilise ceux qui sont fortement producteurs de déchets.

Il faut donc imaginer une solution différente. Deux idées sont à retenir:

◆ la gestion des déchets peut être donnée en propre à un prestataire. Cette solution a l'avantage de la clarté et n'alourdit pas trop la coordination du chantier. Cependant, il est à craindre qu'elle ne responsabilise pas plus les différents corps de métier. On peut penser que cette option est plus adaptée aux petits chantiers.

◆ la gestion des déchets peut être à la charge de chaque corps de métier, comme une prestation supplémentaire. Cette option nécessite une tâche de coordination plus importante à définir entre le pilote du chantier ou le maître d'oeuvre et le gestionnaire du compte prorata pour la gestion de bennes.

Pas de solution miracle, donc, mais un certain nombre de pistes à examiner avec des maîtres d'ouvrage motivés.

◆ Une idée à creuser: les centres de tri spécialisés

Sur certains chantiers, il peut être difficile de mettre en place un tri des déchets en raison de la taille du chantier, de la place disponible, etc. Une solution intermédiaire entre le tri sur le chantier et le choix d'un prestataire est la déchetterie spécialisée. De telles installations sont rares en France, mais quelques expériences existent (Chambéry, Le Havre). Ces centres de tri acceptent les déchets de chantier en mélange ou avec un tri minimum et pratiquent des tarifs très étudiés, selon le type de déchet et son degré de tri. Cette solution permet aux entreprises de ne pas payer le prix fort à des prestataires de services non spécialisés dans les déchets de chantier.

De tels centres de tri résultent d'initiatives privées : des entreprises du bâtiment qui veulent mettre en place au niveau local des solutions adaptées à leurs besoins peuvent être à l'initiative de ces expériences qu'il faut encourager.

4. L'aspect économique ou financier de la gestion des déchets

Les solutions techniques qui émergent aujourd'hui sont faisables à un coût ou surcoût peu élevé. Si on ne gère pas les déchets, on devra payer le prix fort pour leur élimination lorsque la réglementation sur les déchets sera appliquée. Par contre, si on les gère, on arrivera à réduire le coût par type de déchet au strict minimum.

◆ Les coûts à la tonne de déchets : un exemple en France (Tableau 1)

Les pourcentages de déchets sont donnés par rapport à une moyenne nationale – FNB (Fédération Nationale du Bâtiment), ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie). Les prix à la tonne sont des prix moyens en France, en 1995, de valorisation des différents types de déchets. Le prix final (dernière colonne) est le prix de valorisation pour une tonne de déchets mélangés, sans tenir compte des coûts de tri sur le chantier.

L'hypothèse de tri prise ici est la valorisation des métaux et des bois non traités ; elle pourrait être affinée, au gré des filières locales de valorisation des déchets : plâtre, plastiques, cartons, etc.

◆ Les coûts au logement neuf construit (Tableau 2)

Le tonnage de déchets produits par m² construit dépend beaucoup du système constructif. Sur des chantiers de référence, sans tri et sans réduction de la production de déchets à la source, le volume de déchets varie de 5 à 11 m³ par logement. Les chantiers expérimentaux ont permis de ramener ce tonnage à 3 ou 4 m³ par logement. Les coûts au logement sont très dépendants des tonnages atteints, des prix de valorisation des déchets pratiqués dans chaque région, etc. On peut donner quelques chiffres *indicatifs*, pour un chantier de 20 logements (Tableau 2).

Tableau 1

	%	F/t	prix (F)
INERTES	87,8	50	43,90
Déchets industriels banals (classe II)	5,1	500	25,50
Déchets industriels spéciaux (peintures, bois traités, ...)	2,7	1000	27,00
Métaux	1,9	0	0,00
Bois non traités	2,6	0	0,00
Déchets en mélange	100,0	600	
TOTAL SANS TRI (en F/t)			600,00
TOTAL AVEC TRI (en F/t)			96,40
Total sans tri envoyé illégalement en classe III (Déchets dits « inertes »)			50,00

Tableau 2

	sans réduction de déchets	avec réduction de déchets
t/logement	7	3,5
coût en F/logement avec envoi en classe II sans tri	4 200	2 100
coût pour 20 logements sans tri ni valorisation	84 000	42 000
coût en F/logement avec tri et valorisation	675	337
coût pour 20 logements avec tri et valorisation	13 500	6 740
coût pour 20 logements sans tri et envoi illégal en classe III (déchets « inertes »)		7000

Ce tableau illustre le constat fait sur les réalisations expérimentales terminées : le tri et la valorisation permettent de faire baisser le coût de la gestion des déchets de manière très significative, de 84 000 F à moins de 10 000 F. De fait, ce coût se rapproche du coût des pratiques non réglementaires, comme celle, encore fréquente, d'envoyer des déchets non triés en centre de stockage classe III.

5. Quelle méthodologie pour évaluer les fillières d'élimination des déchets ?

L'idée de base est de confronter des « profils environnementaux » à « des coûts de filière » : chacune des solutions choisies pour tel ou tel type de déchet peut être caractérisée selon un critère environnemental et implique un coût.

Le critère environnemental le plus simple en matière de déchets de chantier est celui de la «noblesse » de la valorisation. La plus noble est la réutilisation du déchet comme produit, sans traitement ; puis vient le recyclage « matière », c'est-à-dire avec différents degrés de traitement ; puis la valorisation énergétique ; enfin le stockage (en centre de stockage réglementé). Ces différentes solutions peuvent éventuellement se quantifier en tonnages valorisés ou résiduels, en kW produits, etc.

Evaluer le coût d'une filière n'est pas difficile lorsqu'on connait la filière. Il faut additionner les coûts de cette filière depuis le chantier (les bennes, le transport, le service de tri ou de conditionnement du déchet) et retrancher les bénéfices (vente ou valorisation du déchet).

Ces deux critères permettent de constituer différents scénarios sur le chantier, et surtout de les comparer sur le plan écologique et sur le plan économique.

A ces évaluations, il convient de rajouter une appréciation parfois difficile à quantifier, mais nécessaire : la faisabilité sur le chantier de tel ou tel tri demandé au personnel, le critère économique n'étant pas le seul permettant de jauger la faisabilité.

6. Conclusion

Un des enseignements majeurs des chantiers expérimentaux en France est que pour gérer ses déchets de chantier, l'entreprise doit travailler sur le chantier dès la conception et la préparation du chantier, mais elle doit également s'ouvrir sur le monde extérieur:

- lors de la préparation du chantier dans l'identification des filières locales de valorisation,
- de manière plus générale, dans la mesure où la valorisation des déchets est une activité intersectorielle, dans la concertation avec les autres secteurs d'activité et avec les pouvoirs publics locaux.

En effet, pour gérer les déchets de chantier, il faut que ceux-ci soient pris en compte dans les plans d'élimination des déchets préparés par les pouvoirs publics.

Les maîtres d'ouvrage ne se précipitent pas avec enthousiasme dans la gestion des déchets de chantier, car elle n'échappe pas aux lois du marché économique : elle a un coût et celui-ci est d'autant plus élevé qu'en France aujourd'hui:

- les filières de valorisation ne sont pas encore en place et celles qui existent sont le plus souvent inadaptées aux déchets de chantier ;
- les coûts de mise en décharge, s'ils croissent trop vite aux yeux de certains, n'ont cependant pas encore atteint leur « niveau d'équilibre ». En effet, si ces coûts prenaient en compte les coûts réels de traitement des déchets et la volonté des Pouvoirs Publics de favoriser la valorisation des déchets, par un système de taxes ou de primes par exemple, les coûts de la mise en décharge et du traitement des déchets serait plus « équilibrés ».

Grâce à l'établissement de plans régionaux, départementaux ou locaux d'élimination des déchets, des filières de valorisation vont être mises en place. Il est donc indispensable que le secteur du bâtiment participe à l'élaboration de ces plans.

Il est également important d'aider les services d'urbanisme locaux qui ne traitent le plus souvent que des déchets ménagers à intégrer les préoccupations liées aux déchets de chantier dans l'élaboration de ces plans.

Enfin, la valorisation des déchets implique une vision intersectorielle, puisqu'il faut raisonner le plus souvent par filière matériau. La concertation avec les autres secteurs d'activité est donc une nécessité vitale, qui peut se faire lors de l'élaboration des plans d'élimination des déchets par les pouvoirs publics au niveau local, départemental ou régional.

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1. Le compte prorata enregistre les dépenses engagées dans l'intérêt commun, en fournitures et travaux, pour un chantier faisant intervenir plusieurs corps de metier.

◆

L'architecture traditionnelle au service de la construction d'établissements scolaires au Burkina Faso

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Résumé

Basée sur l'étude de cas d'un projet au Burkina Faso, cette communication présente une approche du problème de la construction d'écoles primaires dans les zones rurales d'un pays en voie de développement. Le but du projet est la construction de plusieurs centaines d'écoles primaires rurales dans un minimum de temps, afin de permettre un développement rapide de l'éducation dans le pays. Devant être réalisé avec des moyens financiers limités, un projet d'une telle ambition nécessite la recherche de solutions à la portée de tous et utilisant au maximum les ressources locales. Il faut donc puiser directement dans la tradition vernaculaire, chercher les adaptations possibles, définir des choix logiques et en symbiose avec le milieu, pour enfin concevoir des modèles d'écoles qui soient facilement et rapidement reproductibles à travers tout le pays.

Abstract

This article presents a specific case study, a project undertaken in Burkina Faso, detailing one approach which can be taken to the problem of building primary schools in the rural areas of a developing country. The aim of the project is the construction of several hundred rural primary schools within the minimum of time, to enable the country's educational system to be quickly developed. As only very limited funds were made available for the project, the nevertheless ambitious nature of the project required that readily available and achievable solutions be found whilst maximising the use of local resources. As such, there is a need to draw on resources from common customs, look at ways these can be adapted, and set out logical solutions which nevertheless remain intricately linked to the environment, in order finally to design school models which can be easily and quickly reproduced throughout the country.

Resumen

Basada en el estudio de caso de un proyecto en Burkina Faso, esta comunicación presenta un enfoque del problema de la construcción de escuelas primarias en las zonas rurales de un país en vías de desarrollo. La finalidad del proyecto es la construcción de varios centenares de escuelas primarias rurales en un mínimo de tiempo, para permitir un desarrollo rápido de la educación en el país. Dado que debe ser realizado con medios financieros limitados, un proyecto tan ambicioso requiere buscar soluciones al alcance de todos y utilizar al máximo los recursos locales. Por tanto, hay que investigar directamente en la tradición vernacular, buscar las adaptaciones posibles, definir opciones lógicas y en simbiosis con el medio y, por último, diseñar modelos de escuelas que puedan reproducirse fácil y rápidamente a través de todo el país.

Introduction

Afin de scolariser 40 % des enfants burkinabés, le gouvernement du Burkina Faso a décidé de lancer un grand projet de développement scolaire comprenant, entre autre, la construction d'environ 2000 écoles primaires dans les zones rurales du pays.

Pour répondre à ce programme très ambitieux, l'hypothèse de base du gouvernement est de s'appuyer sur les ressources locales, matériaux et main d'oeuvre.

La terre étant un des matériaux essentiel utilisé dans la construction traditionnelle burkinabée, le CRATerre, équipe française spécialisée dans ce domaine depuis plus de 15 ans, a été chargé de faire l'étude de faisabilité technique et de mener, conjointement avec le Bureau du Projet Education du Ministère de l'enseignement de base et de l'éducation de masse, un programme préliminaire de réalisations pilotes.

Ce programme bénéficie de l'appui financier de l'Agence internationale pour le Développement de la Banque Mondiale.

Deux types de construction

◆ Construction de type européen

Au Burkina Faso, la construction d'écoles primaires en milieu rural a débuté au début du siècle. Conçues selon des modèles européens, ces écoles ont profité de la technologie moderne développée en Europe depuis le siècle dernier et donc des nouveaux matériaux de construction jusqu'alors inconnus dans ces régions: béton, béton armé, blocs d'aggloméré, charpente en bois scié ou métallique et tôle ondulées. Bien entendu, de tels matériaux n'ont pu être mis en oeuvre par les populations locales et il a été fait appel à des équipes spécialisées.

Edifiées dans le cadre d'un système centralisateur, ces écoles ont été bâties selon des modèles uniques. Des variantes et diverses évolutions des plans correspondant aux différents programmes successifs sont faciles à reconnaitre lorsqu'on se déplace à travers tout le pays.

Implantée avec une volonté humaniste, l'école primaire de type européen (**figure 1**) a été conçue, calculée, et bâtie en matériaux durables, satisfaisant l'ingénierie moderne, persuadée de la justesse et de l'universalité des solutions techniques de construction qu'elle impose. Ce parti pris a exclu toute préoccupation envers le milieu dans lequel elle s'est intégrée, et toute réflexion concernant l'impact possible sur ce milieu.

◆ Construction traditionnelle (figure 2)

Tout au contraire, l'habitat traditionnel issu des traditions locales très diversifiées, varie beaucoup selon les régions, les groupes ethniques et leurs implantations géographiques. L'organisation des espaces, les formes, les matériaux et les techniques de mise en oeuvre sont en harmonie avec le milieu écologique, les croyances et le mode de vie et obéissent parfois à des règles extrêmement précises. D'une durabilité limitée, ces constructions sont souples et permettent une constante adaptation aux évolutions sociales, culturelles et politiques. Ainsi, un agrandissement de la famille se résout facilement par l'adjonction d'une nouvelle cellule à la concession ; la réfection périodique des enduits peut être l'occasion de satisfaire à une nouvelle mode de décoration ; une concession est facilement déplacée en conservant les matériaux les plus précieux ; des typologies correspondant à un système de défense disparaissent, etc.

L'école de type européen

Malgré certains défauts, les bâtiments scolaires de facture importée ont représenté et représentent encore souvent le symbole de la modernité. De part leur dispersion géographique et de part leur fonction, ils sont les ambassadeurs de la modernité au Burkina Faso. Si on ne peut les considérer comme l'unique source d'inspiration du fait de la présence de bâtiments similaires édifiés dans les gros villages et les villes, les bâtiments scolaires sont en grande partie responsables de l'arrivée d'une nouvelle typologie d'habitat, présente dans tout le pays.

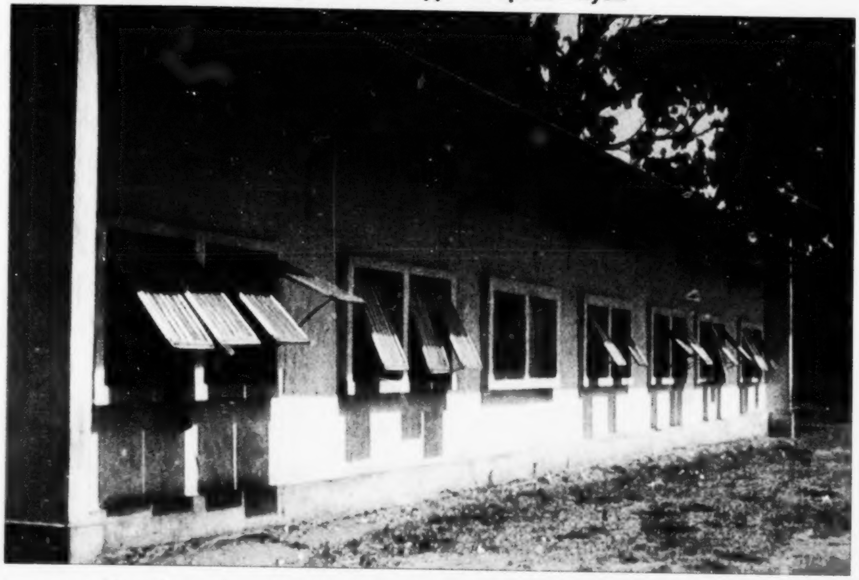
On peut différencier deux principales variantes, correspondant à deux modes d'organisation de la concession issues de la tradition initiale. Le premier type est une composition de pièces uniques et indépendantes autour d'une cour, le deuxième type est un habitat en bloc, regroupant plusieurs pièces sous un même toit, exception faite de la cuisine qui est toujours séparée.

Cette nouvelle typologie est un hybride de traditionnel et de moderne. Les murs sont faits de blocs d'adobe hourdés au mortier de terre. La toiture est en tôles ondulées importées d'Europe, fixées sur des chevrons en bois sciés importés de Côte d'Ivoire. Imitant la toiture plate fréquente dans l'architecture traditionnelle, le toit a une seule pente, très faible, et il est couronné par un acroterre en adobe sur trois côtés. L'utilisation de la tôle ondulée entraîne un abandon systématique du plan circulaire au profit des plans orthogonaux. Dans certaines régions, l'adobe est aussi une technologie récente. Plus qu'une évolution, ce nouveau modèle est donc, dans certains cas, une transformation radicale du cadre bâti.

Bâtir une telle maison est aussi un signe de richesse et donc une façon de se valoriser à l'intérieur du groupe social. Ce nouveau type est effectivement beaucoup plus onéreux que les modèles traditionnels originaux. S'il est encore possible de bâtir avec des matériaux uniquement locaux, et donc de construire gratuitement (autoconstruction), le nouveau modèle représente par contre une dépense obligatoire, l'achat des matériaux importés, et parfois la rémunération d'un artisan spécialisé.

Du fait de ces surcoûts et de la faible capacité économique des populations rurales burkinabées, l'évolution est relativement lente. C'est ainsi que les divers modèles se côtoient, même à l'intérieur d'une concession, avec la transformation successive des diverses pièces indépendantes, selon leur importance hiérarchique. Cependant, les pièces et les édifices utilisés pour des cérémonies rituelles restent immuables car ils doivent respecter des règles très précises.

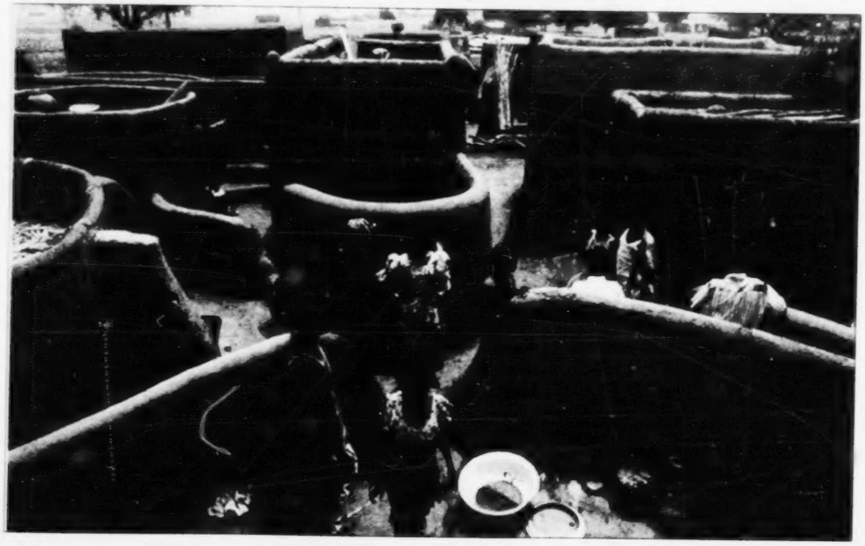
Figure 1
Ecole primaire de type européen à Kyon



La transformation de la construction traditionnelle a apporté une certaine amélioration, surtout en ce qui concerne la toiture qui ne nécessite plus d'entretien (**figure 3**). Mais, à l'inverse, l'utilisation de cette nouvelle toiture entraîne dans de nombreux cas une durabilité inférieure des murs de terre qui la supporte. Dans certains cas, la durabilité globale de la construction devient donc inférieure à celle des modèles antérieurs.

Si l'image tout à fait moderne est obtenue par l'application d'enduits de sable et ciment, ce n'est là bien souvent que leurre car le résultat technique à long terme est souvent moins bon. De fait, la dévalorisation et le rejet des méthodes de construction traditionnelles dans le milieu moderniste burkinabé ne font que s'amplifier.

Figure 2
Habitat traditionnel près de Tiebele



Les écoles primaires rurales récemment construites par le gouvernement

Les toutes premières écoles primaires ont été bâties avec des budgets importants. Depuis l'indépendance du Burkina Faso, ces niveaux de budgets ont été conservés. Or, si l'on pouvait espérer un développement économique du pays qui aurait pu permettre de poursuivre la construction à grande échelle d'écoles primaires rurales, on constate actuellement qu'il n'en a rien été. Le déficit actuel est donc très important, malgré les efforts continus du gouvernement burkinabé.

Le problème est essentiellement économique. Ces constructions sont trop chères. Elles utilisent beaucoup de matériaux importés qui sont de plus en plus coûteux et qui doivent être transportés sur des distances importantes et sur des chemins parfois très difficiles. Les technologies utilisées obligent de passer les contrats de construction avec des entreprises qui, basées dans les grandes villes, facturent des primes d'éloignement.

Toutefois, l'aspect technique est important aussi, mais pour une autre raison. En effet, les artisans et entreprises capables de soumissionner de tels marchés sont trop peu nombreux au Burkina Faso. Il est donc difficile de construire en grand nombre de façon simultané. N'ayant pas de marge bénéficiaire très importante, les entrepreneurs font très souvent la réalisation sur des durées extrêmement longues. Il y a donc aussi un problème de vitesse d'exécution ne permettant pas de suivre le planning d'implantation prévu.

Faire appel à des entreprises internationales serait possible, mais avec une augmentation des coûts beaucoup trop importante. C'est d'ailleurs une option opposée qui a été récemment introduite par le gouvernement, puisqu'il demande la participation des populations locales. Cette solution a connu un relatif échec puisqu'il est difficile d'obtenir une réelle participation du fait de méconnaissance technique ou des faibles moyens pour transporter des matériaux tels que le sable et

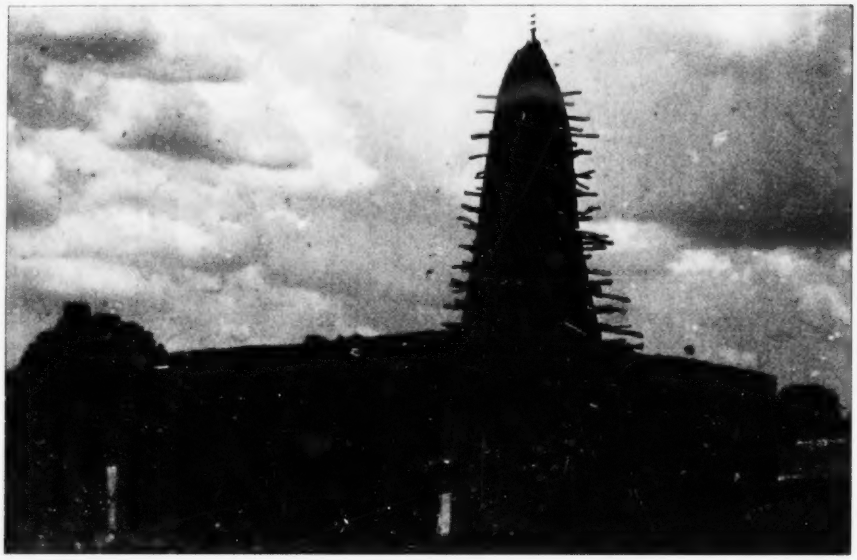


Figure 3
Transformation du modèle de mosquée, près de Gaoua

le gravier qui se trouvent souvent à des distances très importantes du site de la construction. Si le coût est effectivement réduit, la durée d'exécution est encore rallongée.

Les écoles primaires rurales «autoconstruites»

Dans les zones rurales, le manque d'écoles primaires a déclenché un mouvement important de prise en charge de leur construction par les populations locales, souvent sous la direction d'une autorité locale, représentant du peuple élu ou personnalité religieuse (**figure** 4). Si certaines de ces écoles sont vraiment sommaires, la plupart sont bâties sur les modèles européens et très souvent selon la nouvelle typologie, hybride, décrite précédemment. Ce mouvement présente le gros avantage de se baser sur des financements locaux retombant sur les forces productives locales et participe donc très directement d'un développement réel par et pour les populations locales.

Le coût de ces écoles est environ 5 à 10 fois moins important que celui des écoles construites par le gouvernement. Toutefois, la comparaison doit aussi tenir compte de la qualité de la construction ainsi que de la qualité, du point de vue éducatif, des espaces créés.

Bâtis selon les mêmes principes que le modèle hybride d'habitat, ces écoles en possèdent les qualités et les défauts techniques. Si elles possèdent l'image moderniste, elles sont souvent d'une durabilité assez limitée, dépendant beaucoup de l'entretien et de sa fréquence.

La nécessité de franchir une portée assez importante, deux fois environ celle de l'habitat classique, pose des problèmes importants pas toujours bien résolus. Le besoin de lumière et donc de fenêtres de grandes dimensions pose aussi les problèmes techniques du linteau et de l'ancrage dans la maçonnerie, et provoque des nouvelles érosions du mur de terre au niveau de l'allège.

Les espaces obtenus ne sont que rarement bien adaptés aux besoins éducatifs. Les défauts les plus couramment constatés sont : salles de classe trop petites, faiblesse de l'éclairage, mauvaise ventilation, auxquels on doit ajouter les problèmes inhérents à l'utilisation de la tôle : bruit très important causé par l'impact de la pluie et forte chaleur dans les salles de classe.

La qualité des logements d'instituteurs est en général meilleure car ces constructions sont plus proches, voire identiques, au modèle hybride d'habitat, et donc mieux maîtrisées.

La nouvelle politique de constructions scolaires en milieu rural : le projet éducation

Le but du gouvernement burkinabé est la scolarisation de 40 % des enfants burkinabés d'ici 1995-1996, et donc, entre autres, la construction d'environ 2000 écoles comportant principalement trois classes et trois logements d'instituteurs. D'évidence, la réalisation d'un tel projet ne pouvait se concevoir avec les moyens utilisés précédemment et une autre solution a dû être envisagée. La seule hypothèse vraiment possible et qui a finalement été retenue est le soutien au mouvement existant d'autoconstruction par l'appui aux communautés rurales désireuses d'implanter une école dans leur village ou groupe de villages.

Pour vérifier la faisabilité d'un tel programme, une analyse précise de la construction et de son évolution dans les zones rurales burkinabées a été nécessaire. Un travail important a été mené pour connaître les matériaux locaux, les techniques de mise en oeuvre, les savoir-faire, l'architecture et les modes d'organisation traditionnels de la construction. Ces enquêtes sur le terrain et leur dépouillement ont confirmé l'existence de savoir-faire qui pouvaient être parfaitement adaptés à la construction d'écoles primaires et ont démontré l'intérêt de la solution envisagée.

Un principe de financement et de gestion des projets, responsabilisant directement les autorités et les populations locales, a été mis au point. Concernant la conception du projet lui-même, la méthode utilisée a consisté à s'inspirer le plus possible de la tradition burkinabée, en partant du modèle d'école primaire auto-construite existant, et en tentant de résoudre les problèmes techniques qui lui sont liés, tant en ce qui concerne la qualité des espaces que la durabilité et la réduction des besoins en entretien. On a choisi d'utiliser au maximum les technologies traditionnelles et de les adapter de façon à améliorer la qualité et la durabilité. Les éléments des bâtiments qui devraient être réalisés en matériaux importés ont été finement sélectionnés. Leur coût représente la quasi totalité de la subvention versée par le gouvernement à la communauté rurale.

Ainsi conçu, un premier prototype a été construit à Nomgané prés de Ouagadougou. Cette réalisation a permis de vérifier la pertinence des options de base. Les résultats sont encourageants tant du point de vue financier que du point de vue technique et organisationnel, ce qui permet d'envisager de façon réaliste une réalisation à grande échelle.

Le suivi systématique du chantier a permis d'accumuler nombre d'informations qui se révèlent très complémentaires aux informations collectées lors des enquêtes de terrain. On a constaté la nécessité de travailler méthodiquement afin de bien dégager les avantages et les inconvénients de chaque solution technique, avec pour but la simplicité maximale pour obtenir une efficacité acceptable. Il faut aussi trouver des moyens clairs et adaptés pour transmettre le projet et les détails techniques nouveaux, de façon à ce que la réalisation soit correcte.

Une des grosses difficultés est de véritablement assimiler la culture locale et de l'intégrer sans faire systématiquement référence à la culture occidentale, de façon à établir des règles et des normes adaptées au contexte, avec, toutefois, la garantie de la durabilité des bâtiments. Cet aspect technique doit aussi être mis en balance avec l'image de l'école. Elle doit satisfaire à la fois les communautés rurales et surtout leurs représentants, qui sont alors motivés pour participer activement à la construction, et les instituteurs afin qu'ils soient valorisés, qu'ils aient suffisamment de respect pour ces constructions et donc la volonté d'organiser l'entretien nécessaire. Un travail important de valorisation de l'école primaire rurale en matériaux locaux est à faire.

Un aspect très important sera de bien informer les instituteurs sur le comportement dans le temps de ces écoles et de leur donner les solutions logiques d'entretien et de réparation. Ceci devrait permettre d'éviter les erreurs trop fréquentes actuellement et surtout, la transmission de ces erreurs aux populations locales, avec pour résultat un nouvel effet de dévalorisation de la construction traditionnelle.

Nouvelles écoles : nouveau modèle ?

Un maçon ayant travaillé sur le premier chantier a repris le plan du logement d'instituteur ainsi que certains des détails techniques pour construire sa propre maison. C'est un signe prometteur et riche d'enseignements mais qui amène à une nouvelle réflexion. Ce nouveau programme de construction d'écoles primaires en milieu rural ne risque-t-il pas d'avoir pour effet induit une nouvelle évolution de la tradition telle que celle qui s'est déjà produite?

C'est alors une responsabilité supplémentaire. Mais le projet en devient d'autant plus logique. En effet, le travail s'oriente de plus en plus vers une tentative d'orientation du processus d'évolution, et se propose d'arriver à une réelle amélioration du modèle existant, tout en restant dans des coûts et des techniques de construction accessible à la majorité des populations.

Contrairement à ce qui s'est produit ces dernières années, cette nouvelle évolution pourrait alors se faire de façon plus naturelle, et être alors une véritable modernité dont profiteraient les populations rurales, voire peri-urbaines.

La bonne orientation du projet ne se mesurera certainement pas seulement par le nombre d'écoles construites, mais aussi dans l'appropriation de ce nouveau modèle, et donc sa reproduction spontanée par des Burkinabés.

Conclusion

La construction traditionnelle, sous ses formes extrêmement variées, résout toujours une majeure partie des besoins en habitat au Burkina Faso et déjà, dans une proportion relativement importante, les besoins en bâtiments éducatifs ruraux.

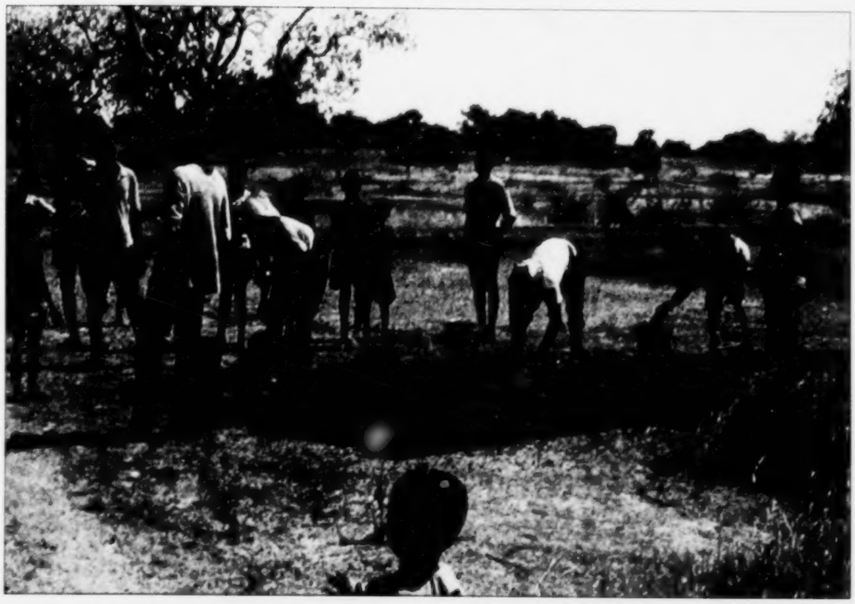
Dans le cadre de la politique actuelle, et au vu des premiers succès enregistrés, il est envisageable qu'à moyen terme les techniques traditionnelles permettent de bâtir une infrastructure scolaire très importante et le développement d'un réel enseignement de masse au Burkina Faso, comme le souhaite le gouvernement.

Le succès du projet dépendra de la capacité du projet à s'intégrer à l'intérieur des structures existantes, de sa compréhension par les populations et enfin de sa reproductibilité. N'étant pas question d'un retour aux sources, il s'agit de proposer des modèles qui, tout en utilisant des pratiques anciennes, soient un réel pas en avant vers la modernité.

D'ores et déjà, on sait qu'il faudra procéder par étapes en engageant d'autres chantiers pilotes, en continuant le suivi et l'étude des pratiques opérationnelles, en étant à l'écoute des remarques diverses et en testant des moyens de transmettre les informations techniques.

Plusieurs nouveaux projets, différents les uns des autres, sont actuellement en cours de construction. Ils prouvent que cette méthode est efficace car des progrès considérables ont été faits par rapport à la première réalisation.

Figure 4
Les villageois se mobilisent pour construire eux-mêmes leur école : fabrication des briques d'adobe



De nouvelles informations sont recueillies. Elles permettront d'encore mieux se rapprocher des compétences humaines existantes, de mieux connaître les possibilités et d'améliorer les propositions, afin d'arriver à une meilleure utilisation des ressources locales.

Mais les processus sont complexes et parfois bien difficiles à analyser et beaucoup de chemin reste à faire avant d'atteindre le but fixé.

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Consultation with national experts: managing contaminated land

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Abstract

Some countries may not have sufficient skills and resources to address issues associated with contaminated land. Approximately half the countries which took part in a recent UNEP IE consultation indicated that this was the case. While land contamination is addressed in the national environment programmes of the majority of the respondents, adequate information is often not available on contaminated land management. Approximately three-quarters of the respondents indicated their country had some form of legislation to control land pollution. However, regulatory controls often do not exist explicitly for this type of pollution.

Résumé

Tous les pays ne disposent pas de toutes les compétences et ressources nécessaires pour résoudre les problèmes associés à la contamination de sites terrestres. Environ la moitié des pays ayant pris part à une consultation du PNUE IE l'ont confirmé. Alors que ce type de contamination est pris en compte dans les programmes nationaux pour l'environnement, il arrive fréquemment que les informations pertinentes sur la gestion des sites ne soient pas disponibles. Environ les trois-quarts des participants ont indiqué que leur pays s'est bien doté d'une législation visant à contrôler la pollution terrestre, mais qu'il existe rarement des dispositions réglementaires explicites à cet effet.

Resumen

Es probable que algunos países no tengan capacidades ni recursos suficientes para afrontar problemas relacionados con terrenos contaminados. Aproximadamente la mitad de los países que tomó parte en una encuesta reciente de la UNEP IE admitió que éste era el caso. Los encuestados admitieron que aunque en la mayoría de los casos la contaminación de terrenos se incluye en los programas medioambientales nacionales, con frecuencia no existe información adecuada sobre la gestión de terrenos contaminados. Casi el 75% de los encuestados indicó que en sus países existía cierta forma de legislación sobre el control de la contaminación de terrenos. Sin embargo, a menudo no existen controles reguladores exclusivamente dedicados a este tipo de contaminación.

Introduction

Contaminated land is an issue worldwide, and is not restricted to developed economies. Awareness of land contamination as a problem within a country is often low, particularly amongst politicians and the public. The consequences of land contamination can often be very serious for man and the environment. Remediation is usually very expensive and is often difficult.

However, land contamination can be managed. Policies must be developed to deal with the problem within a country. Polluted sites need to be identified and monitored, and those presenting a high risk to human health or the environment need to be cleaned up. Potential sources of soil pollution must be identified and monitored. Regulatory controls must be developed and implemented nationally. Overall, however, the prevention of land contamination must be the aim.

As part of a current UNEP initiative on contaminated land, UNEP IE is preparing a Technical Report, *Management of Contaminated Land*. This report will give direct and practical advice to countries that have little experience of soil contamination, but where it may be become a serious problem in the future. It will provide advice to national authorities and experts on the best means of identifying, evaluating and solving soil contamination problems in their country. The report will review current procedures and technologies in use around the world and indicate the most practical approach for countries newly aware of this issue.

UNEP has already developed a trainers package entitled *Risk Management of Contaminated Land* (1994) that goes some way towards providing the skills required to manage the problem of land contamination effectively.

The survey

As input to the preparation of the Technical Report, UNEP IE sent a short questionnaire to selected officials and experts in a variety of countries (developed and developing). The aim of this consultation was to obtain information concerning the level of awareness of issues associated with contaminated land, the priority these issues have in national environmental agendas, details of current and potential soil contamination problems, and details of any studies or remedial activities already carried out on contaminated land as well as the expertise available in different countries.

This consultation exercise has provided information for the Technical Report that will ensure its relevance to countries in all UNEP regions and reflect what is currently happening and what the potential problems might be with regard to soil contamination.

Preliminary information on land contamination

Experts from a wide range of countries took part in this consultation. The distribution is shown in **Figure 1**. Thirty-five per cent were from OECD countries (Annex 1). Forty-two per cent of the individuals who responded were technical specialists in teaching and research, 39 per cent were from public administration (mostly environmental agencies), and 17 per cent were private consultants. Twenty-two per cent were official government responses.

A significant majority (78 per cent) of respondents agreed that land contamination was a serious issue in their country, as opposed to only 16 per cent who felt it was not an issue (6 per cent of respondents were not sure if it was a serious issue). Respondents included developed as well as developing countries currently undergoing rapid industrialization, and countries not traditionally thought of as industrialized. Thirty-five per cent of OECD countries and 65 per cent of non-OECD countries indicated that land contamination was a serious issue. A high proportion (67 per cent) of respondents indicated that the issue of land contamination was included in their national environment programmes. Again comparing OECD and non-OECD countries, 31 per cent and 69 per cent, respectively, stated that land contamination was included in their national environment programmes.

Only 45 per cent of respondents felt sufficient skills and resources were available in their country to address the issue of soil contamination. Twenty per cent of respondents felt they already had enough information on soil contamination management options. This clearly shows that soil contamination is considered an important issue and that it is being addressed via national environment programmes among the countries consulted, but that skills and resources are often lacking and that many countries do not have sufficient information on management options to be able to deal effectively with the problem. Eighty-nine per cent of respondents from non-OECD countries indicated they lacked information on management options.

Table 1
Potential sources of land contamination

Industrial	gas works, coal processing, extractive industry, mines, chemical production or use, electroplating works, timber preservation, metal production/manufacturing, chemical stores, pesticide formulation, food processing, pulp and paper manufacture, textile production, other industries
Commercial	petrol service stations, transport services/maintenance, motor car wrecking, waste recycling depot/plant
Service sector	municipal/industrial landfills, sewage treatment works, fuel depots, energy generating plants, laboratories
Agricultural	intensive use of pesticides, aerial spraying operations, pesticide storehouses
Other	abandoned dumpsites, abandoned mines, factory or warehouse fire, chemical transport accident

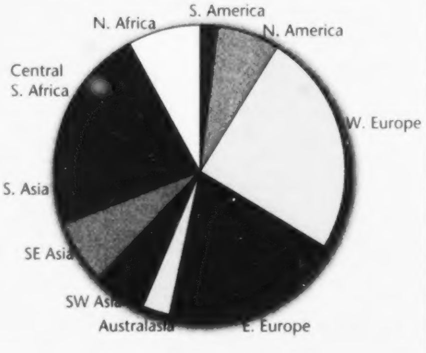
Table 2
Types of land contamination as confirmed or potential sources

Pollution source	Per cent of respondents stating source as confirmed or potential
Municipal/industrial landfill	100
Fuel depots	99
Transport services/maintenance	98
Petrol service stations	98
Metal production/manufacturing	96
Chemical stores	96
Intensive use of pesticides	96
Sewage treatment works	94
Pesticide store-houses	93
Electroplating works	93
Abandoned dumpsites	92
Chemical production or use	92
Factory or warehouse fire	91
Energy generating plants	91

Table 3
Types of land contamination as potential sources

Pollution source	Per cent of respondents stating source as confirmed or potential
Laboratories	80
Food processing	63
Transport services/maintenance	57
Factory or warehouse fire	55
Pesticide store-houses	53
Aerial spraying of pesticides	52
Chemical stores	52

Figure 1
Distribution of respondents worldwide (per cent)



National awareness of soil contamination

Respondents were asked how serious, in their opinion, the issue of soil contamination was in their country, actually and potentially. A majority of respondents (64 per cent) indicated that soil contamination was an actual problem in their country, and 42 per cent, that it was a potential problem. Only 6 per cent of respondents stated that soil contamination was not a problem and not likely to become one (6 per cent). Some respondents (12 per cent) felt that this issue was an actual and a potential problem. Presumably they felt that soil contamination problems in their country were already recognized but that the problem was escalating.

The level of awareness of soil contamination by experts, politicians and the public was also found to vary between countries. Overall, experts (78 per cent) were considered aware whilst politicians (61 per cent) and the public (69 per cent) were considered to have a low or no awareness of the problem. Countries in which soil contamination was considered a serious problem by the survey respondents can be compared with awareness levels of the problem by politicians and the public in those countries. Politicians (50 per cent) had a low or no awareness of soil contamination even though it is considered a serious problem in their country. The figure was also relatively high for the public at 62 per cent. These figures indicate that awareness levels of the politicians and the public of soil contamination as an issue in many countries need raising. This could be done via training and education and better dissemination of information, particularly to the public.

Documented information on land contamination

Many countries (82 per cent) had carried out studies of contaminated sites in their countries. They ranged from sophisticated national surveys to studies on a smaller scale, carried out in areas where land contamination had only recently been identified as a problem. For example:

"Through the National Contaminated Sites Remediation Program initiated in 1989, a fund was available to clean-up high risk orphan contaminated sites and to develop and demonstrate soil and groundwater remediation techniques. Through the program numerous tools for dealing with contaminated sites have been or are in the process of being developed, such as "guides for ecological and human health risk assessments, remediation guides and remediation objectives"

"Few dispersed studies have been carried out on contaminated sites."

"Uncoordinated studies by universities and research institutions."

"There are two studies that have been carried out on contaminated sites. One looked at the situation at two mines; a coal mine and an asbestos mine. The other the effects of wastewater from fruit canning on trace element mobility in soil."

"In the period 1989-92 the authority conducted a nation-wide survey on the registration of hazardous waste in landfills and in contaminated ground. This survey resulted in a total of ca. 3000 registered contaminated sites. The work was carried out through seven independent consulting companies, organized regionally..."

"Industrial and domestic landfill sites were monitored for aquifer contamination. Very few institutions on the island have the expertise to study contaminated sites..."

Of those countries who had carried out some kind of contaminated land study, 28 per cent were on a national scale. All these countries were members of the OECD.

It is clear from the responses received that in countries where land contamination is a recently identified problem, the skills and resources to carry out effective studies are often lacking. Any studies that have been done have often been "unofficial" and carried out in an uncoordinated way.

Respondents were also asked to indicate which institutions, individuals, consultants or government departments in their country had relevant expertise or knowledge with regard to land contamination. A majority of respondents indicated that government departments (71 per cent) and institutions (78 per cent), such as universities, tended to have the expertise and knowledge. Consultants were the next most important source (37 per cent).

Among government departments, ministries of the environment or agriculture were the usual "expert" departments. In many countries, national agencies also have relevant expertise and knowledge. Examples are the National Agency for Environmental Protection (Tunisia), the National Centre for Hygiene (Bulgaria), and the National Environmental Engineering Research Institute (India). The institutions were mainly university departments.

In a significant number (77 per cent) of countries seminars that included land contamination as a topic had been held. This figure corresponds well with the 78 per cent of respondents who felt that land contamination was an important issue in their country.

Seminars have been run on a national and provincial basis in countries such as Canada, the UK and the US. In India, the Ministry of Environment and Forests sponsors workshops and training in land contamination. However, seminars are often few in number in areas where land contamination has more recently been identified. Among many other related areas, seminars (or colloquia) have been run on the following:

- remedial methods of hydrocarbon contaminated sites (Tunisia)
- managing contaminated land (South Africa)
- advances in soil decontamination (Czech Republic)
- pesticide pollution of soils (Bulgaria)
- effects of war on the environment (conference) (Croatia)
- ecology and soil protection of the arid territories (Kazakstan)

Potential sources of land contamination

Items listed in **Table 1** were categorized as either a confirmed source of pollution in the countries surveyed, a potential source (activity was present but no information existed as to its impact), or as source not present/sites monitored and were clean.

Certain sources of potential soil contamination are obviously more important in one area than another. For example, contamination resulting from intensive use of pesticides and aerial spraying operations will potentially cause more of a problem in a predominantly agricultural area than in an heavily urbanized industrial area. There are, however, certain types of soil contamination that seem to be important in the majority of countries that took part in the consultation. These are shown in Table 2.

It is obvious that sources of pollution such as landfills are widespread and can be found in every country consulted. In many countries these types of sources may still be potential sources, i.e. the source is present but there is no information as to its actual impact on the environment.

Figure 2 shows each pollution source ranked in terms of the percentage of respondents indicating the source as confirmed. According to 75 per cent of respondents, municipal/industrial landfills were a confirmed source of soil pollution in their countries. This source presented the highest distribution as a confirmed source of soil pollution. No respondents indicated that this type of source either was not present in their country or that the sites had been monitored and found to be clean. Twenty-five per cent indicated that municipal/industrial landfills might be a potential problem. Clearly municipal and industrial landfill sites present a significant soil pollution problem in those countries consulted. Comments received from respondents include: "There are more than 2,800 municipal landfills in my country and most of them don't comply with the relevant regulations. These landfills generally contain hazardous wastes as well, so they have been directly endangering the environment."

The other type of source gaining a high score as a confirmed or potential source of pollution was fuel depots. Figure 2 shows that 53 per cent of respondents indicated that this was a confirmed source of soil pollution, while 45 per cent said it was a potential problem. This may indicate that although this type of source is found in every coun-

Figure 2
Types of land contamination – Confirmed sources

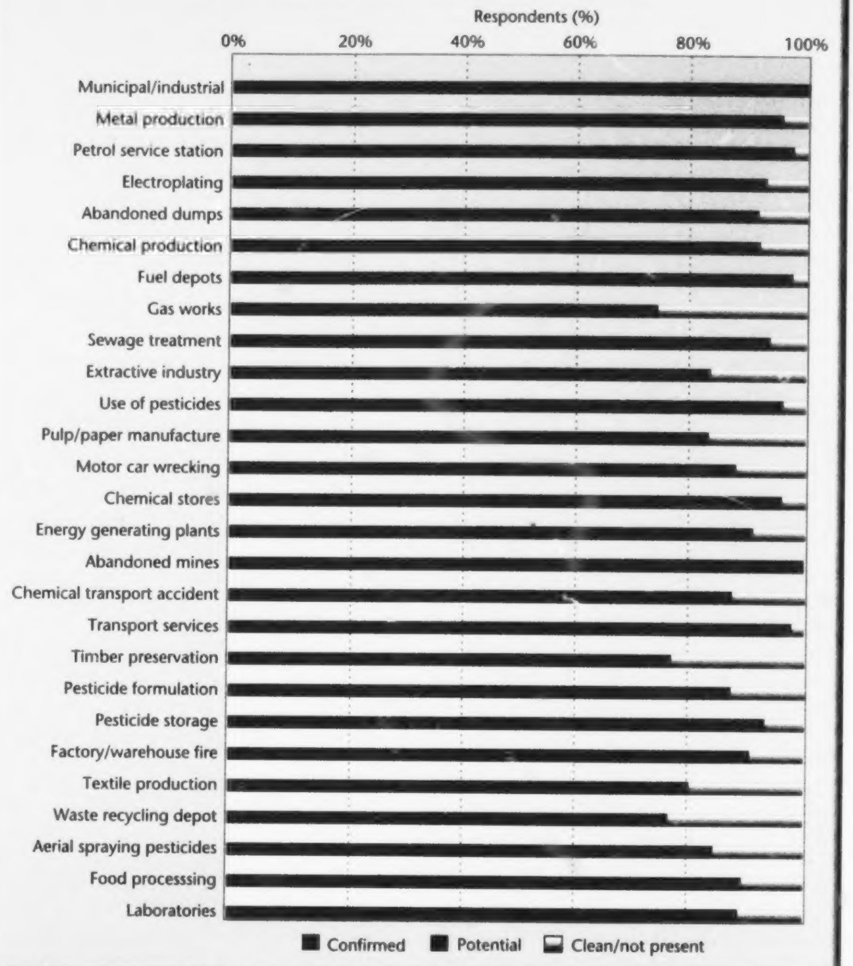


Table 4
Some actual activities to investigate/clean up contaminated sites

Abandoned military sites (Russian Army): fuel depots, fuel transfer stations and pesticide stores. At two military sites liquid fuel has been pumped out from the soil. At some chemical storage areas the clean up of the aeration zone of the soil is being carried out – Poland
More than 20 small firms in our country deal with contaminated soil remediation, the most common remediation technology used is bacterial decontamination – Czech Republic
Clean-up studies have been carried out in Srednogorie on arable lands near to a copper smelter, there is restrictive crop production in this area – Bulgaria
Evaluation of the contamination level in the surface layers of soil in the industrial centre of the Republic by the Geologic Institute of Kazakstan.
Consultants are working on one site in North India to study soil and groundwater pollution caused by toluene, benzene, etc. and are trying to determine best ways of cleaning up the polluted groundwaters.
Contamination assessment and clean-up of several oil depots, boatyards, etc. have been conducted – Hong Kong
Many thousands of sites have been investigated since about 1980 and many hundreds of sites have been cleaned up in the past five to ten years. Most remediation has been limited to excavation with off-site disposal (with or without treatment) – Australia
The Ferihgy International Airport at Budapest has contaminated the soil and the groundwater for years by the activity of fuel plants. A clean-up programme has been carried out by a Hungarian company.
Of the 2000 petrol stations in London at least 25 per cent have had soil gas analysis carried out and many of these have been followed up with full remediation and clean-up of sites – UK
Investigation of the impact of copper mining complexes on soils and some flora of Lake George – Uganda
Actual activities in Sweden are dealing with: mine waste; PCB in sediment; dioxin and mercury contamination; creosote contamination; chromium, copper and arsenic contamination.
Major classes of clean-up in UAE: vehicle service shops (oil); illegal waste disposal to land; one major factory fire and a PCB transformer wrecking site.

try consulted, actual soil investigations have not been carried out in the majority of cases, so that the source remains a potential problem. This could also be the case with transport services/maintenance. Forty-one per cent of respondents indicated that this was a confirmed source of land contamination, but 57 per cent indicated that it was a potential source. This is different to the case of municipal/industrial landfills, where 75 per cent of respondents indicated that this was a *confirmed* source of pollution.

Table 3 gives an indication of the types of sources most likely to be considered potential as opposed to actual, confirmed pollution sources. The most significant are laboratories: only 9 per cent of respondents stated that these were a confirmed source of soil pollution, but 80 per cent felt that they were a potential source. Similarly, in the case of food processing operations, 26 per cent of respondents said they were a confirmed source of soil pollution while 63 per cent felt they were a potential source.

Petrochemical plants/oil refineries, a source of land contamination not listed in Table 1, were indicated by 17 per cent of respondents as a potential or confirmed source of pollution. Of these respondents, 10 per cent were from non-OECD countries.

A wide range of sources not listed in Table 1 were mentioned by individual respondents, including sheep dipping areas in Australia, mink farms in Denmark, tanneries in Pakistan and Ethiopia, former military bases in Latvia, shipbuilding/repair in Malta, and cork processing in Portugal.

Industrialized countries such as the UK or the US give an indication that the types of pollution sources listed as potential sources for developing countries often become confirmed sources of pollution as industrialization continues and soil investigations are carried out, but that many sources of soil pollution are often specific to a limited number of countries.

Contaminated land investigations and clean-ups

Examples of actual investigations of contaminated sites, or examples of any remedial activities, were requested. The overwhelming majority of respondents (85 per cent) said some kind of soil contamination investigation had taken place in their country. The type of investigation varied widely, from sophisticated national programmes to "one-off" investigations. Not all investigations were carried out by government agencies. Institutions such as universities were involved, and consultants often carried out soil remediation or actual soil clean-up contracts. Some of the investigations and soil clean-ups reported are shown in **Table 4**.

Table 4 indicates the types of pollution source actually investigated and cleaned up. Landfill sites and hydrocarbon-based contamination appear frequently.

Regulatory control of land contamination

Respondents were asked to give details of any poli-

Annex 1
Respondents from the countries in Table 5 took part in this survey

Table 5
OECD and non-OECD members taking part in the survey (number of respondents)

OECD Members	Non-OECD Members		
Australia (2)	Bahrain	Kenya	Syria
Canada (2)	Brazil	Latvia	Swaziland
Denmark	Bulgaria (2)	Malta	Tanzania
Germany (2)	Croatia	Mauritius	Thailand
Italy (2)	Czech Republic	Namibia	Tunisia (2)
Norway (2)	Egypt	Nepal	Uganda
Portugal	Ethiopia	Pakistan	United Arab Emirates
Spain	Hong Kong (2)	Poland	
Sweden	Hungary	Russia	
Turkey	India (3)	Slovak Republic	
UK (2)	Kazakstan	South Africa	
USA			

Table of overall results and broken down into OECD and non-OECD countries

Category		Overall (per cent)	OECD (per cent)	Non-OECD (per cent)
Respondent distribution		100	35	65
Land contamination as a serious issue	*Yes*	78	35	65
	No	16	0	100
	Don't know	6	0	100
Part of environmental programme	*Yes*	67	31	69
	No	33	2	98
Sufficient skills	*Yes*	45	23	77
	No	55	11	89
Enough information	*Yes*	20	13	87
	No	80	20	80
Awareness of actual problem	*Yes*	64	35	65
	No	6	0	100
Awareness of potential problem	*Yes*	42	10	90
	No	6	0	100
Potential and actual problem	*Yes*	12	44	56
	No	6	0	100
Expert awareness	*High*	78	34	66
	Low/None	22	2	98
Politician awareness	*High*	39	31	69
	Low/None	61	6	94
Public awareness	*High*	31	20	80
	Low/None	69	14	86
Serious issue and low awareness	*Experts*	11	2	98
	Politicians	50	6	94
	Public	62	14	86
Serious issue and high awareness	*Experts*	89	32	68
	Politicians	50	29	71
	Public	38	18	82
Not a serious issue and low awareness	*Experts*	57	0	100
	Politicians	100	0	100
	Public	100	0	100
Not a serious issue and high awareness	*Experts*	43	0	100
	Politicians	0	0	0
	Public	0	0	0
Studies on contaminated land carried out	*Yes*	82	36	64
	No	18	0	100
Seminars held	*Yes*	77	37	63
	No	23	0	100
Regulations dealing with contaminated land	*Yes*	72	35	65
	No	28	0	100
	Draft	14	0	100

cies, regulations or guidelines, specifically concerning contaminated land, currently in force or in draft in their countries. Of those countries that gave such an indication, 72 per cent said there were regulations, etc. in place, with 14 per cent in draft form. In 28 per cent of countries surveyed there were no regulations, guidelines or policies dealing with land contamination. None of these countries was an OECD member. A further 14 per cent had general environmental protection laws in place. One of these countries was a member of OECD.

Regulations and official guidance take many forms in relation to land contamination:

- provincial guidelines for specific targeted compounds (PAH, heavy metals, chlorinated organics, etc.) in Canada;
- The Pollution Control Act, and the Area Planning and Building Act, in Norway;
- Law 441/87 registration of polluted sites and the setting up of remediation programmes, as well as Law 5/16/89 requirment of remediation plans from each region, of which only seven out of 20 have been done so far, in Italy;
- the Hungarian Environmental Protection Act (draft);
- Public Notice of Ministry of Environment and Ministry for Privatisation (1992) on the assessment of soil contamination and assessment of environmental duties during privatisation, in the Czech Republic;
- draft regulations outlining the power of the Dubai municipality to require any person to clean up a site which is deemed to be polluted, in the United Arab Emirates.

Many of the rapidly industrializing countries have already identified land contamination as a problem, have conducted studies, and have carried out some clean-ups, but legislation has been characteristically slow to respond. Although the majority of countries consulted did have some kind of legislation in place or in draft, this was not always specific to land contamination as discussed above. In order for land contamination to be manged effectively, the development and implementation of effective regulatory controls must be a priority for all countries.

UNEP IE Technical Report on Managing Contaminated Land

There will be a wide range of potential users of the UNEP Technical Report worldwide, although it is aimed at countries where soil contamination has recently been identified as a problem or potential problem. This Technical Report will give practical guidance to authorities and experts on the best means of identifying, evaluating and remedying contaminated land problems in their countries. It will review current procedures and technologies already in use, and will indicate practical approaches for countries newly aware of the problem. The report will be used by technical personnel and those agencies with responsibility for investigation and remediation of contaminated land.

The forthcoming report was welcomed by all respondents, and not just those in developing countries undergoing rapid industrialization. The report's structure and content were felt to be correct, with some minor additions/changes.

Respondents were asked to list potential users in their country and any institutions or training organizations which could implement suggestions in the report. A wide range of potential users was listed, from university departments and government ministries to consultants, indicating that the report will serve a very useful purpose.

Institutions or training organizations that teach the subject of contaminated land (currently or in the future) were also varied. The majority of countries indicated that their universities provided most of the teaching concerning contaminated land. A certain number of respondents did not have any formal teaching taking place in their countries at the moment on this subject.

There is obviously a demand for information with regard to land contamination, and a need for appropriate training and education.

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Global mining: three priorities in a politically challenging world

Synopsis of a presentation given by James P. Cooney, Director International & Public Affairs, Placer Dome Inc., at the Annual International Convention of the Northwest Mining Association, December 4-8, 1995, in Spokane, Washington, USA (reprinted from *ICME Newsletter* Vol. 4, N° 1)

Governments are gradually responding to the need for systems of taxation, regulation and administration which satisfy public purposes without imposing so heavy a burden on the mining industry as to discourage investment. Progress is being made such that the mining industry can operate under fiscal and legal structures that are efficient and effective, as well as transparent, fair, stable and predictable. Whether this favourable trend for continued mining investment is permanent or reversible may depend primarily upon the industry's own performance.

If the mining industry wants to sustain its welcome around the world, then changes may be required in some of its thinking and practices. Firstly, the mining industry needs to reach out to credible institutions such as aid agencies and global non-governmental organizations (NGOs) which are focused on environment (assuming they are scientifically oriented and not purely political), or on social and economic development, or on particular interests, such as indigenous peoples. Within countries, the industry needs to be clearly allied to the interests of communities in a strong spirit of cooperation with their local institutions. Mining companies, constituting a global wealth-creating industry, need to define their interests and relationships broadly, beyond the narrow interests of their mining operations.

Secondly, the industry needs to articulate and respect the ethical principles that relate to its activities. Corruption, human rights and social issues in many developing countries raise ethical challenges. These are likely to become as demanding of the industry's attention and its ability to respond as have been environmental challenges during the past couple of decades. Multinational mining companies will need to develop global ethical principles and hold themselves accountable to acting in conformity with them.

Thirdly, there is a need to define activities in the framework of "sustainable development". This policy orientation has been embraced by most governments, including those of many developing countries. The key theme of sustainable development is utilizing resources today while respecting the needs of future generations. The mining industry will do itself a disservice if it rejects the concept of sustainable development at a time when a number of governments are attempting to structure their economic and social policies within that framework.

Key elements of sustainable development include effective public consultation with populations affected by mine development, equitable wealth distribution from mining to local communities, and effective management of the environmental and socio-economic impacts of mining both during operations and after mine closure. A consistently high level of environmental performance is absolutely key to the long-term acceptability of mining in many jurisdictions.

Mining will also be judged by its social legacy after mines close. Are people in the region around the mine more educated and healthier, and thus able to live more productive and satisfying lives, even when the mine which helped bring about those improvements is no longer operating? Are businesses which got their start in response to the opportunity offered by the mine able to sustain themselves in alternative markets after the mine closes? Can the physical infrastructure which was developed to support the mine be put to other economically beneficial uses? The industry must demonstrate that the legacy of mining consists of sustainable social and economic improvements.

The global mining industry is gradually coming to terms with the sustainable development agenda. Ultimately, it will be judged by the quality of its performance, not only technically and economically, but environmentally, socially and ethically as well. It remains to be seen whether the industry has the collective inspiration and will to sustain its welcome over the long term in the many countries in which it operates.

Tourism Focus

A regular section reporting on developments in the field of sustainable tourism,
and on the activities of the UNEP Tourism Programme

N° 5

Environmental reviewing for the hotel sector: the experience of Inter-Continental Hotels and Resorts

Rebecca Hawkins, Jersey Tourism (former Deputy Director of the World Travel and Tourism Environment Research Centre, Oxford, UK)

Abstract

Inter-Continental Hotels and Resorts has more than 170 hotels in 67 countries. It is one of the first major international hotel companies to incorporate environmental issues into its mission statement and adopt a comprehensive approach to environmental management. The company has gone on to share its environmental management experience by acting as a founder partner of the International Hotels Environment Initiative (IHEI), through which it has sought to encourage other hotel companies to improve their environmental performance. In 1996 it compiled a review of progress to date, the first review of this nature published by an international hotel company.

Résumé

La société Inter-Continental and Resorts possède plus de 170 hôtels dans 67 pays. Elle a été l'une des premières grandes sociétés hôtelières à inclure le respect de l'environnement dans sa déclaration de mission et à adopter une approche globale de la gestion de l'environnement. A titre de membre fondateur de l'IHEI (International Hotels Environment Initiative), elle s'est attachée à encourager d'autres sociétés hôtelières, avec lesquelles elle partage son expérience de la gestion de l'environnement, à améliorer leur action dans ce domaine. En 1996, elle a établi un bilan des progrès réalisés jusqu'à présent ; c'est le premier bilan de ce type publié par une société hôtelière internationale.

Resumen

La cadena de Hoteles y Centros Vacacionales Inter-Continental cuenta con más de 170 hoteles en 67 países. Fue una de las primeras sociedades hoteleras en interesarse en los problemas medioambientales y en adoptar un enfoque global en la gestión medioambiental. La sociedad ha decidido compartir su experiencia medioambiental al actuar como socio fundador de la Iniciativa Medioambiental de Hoteles Internacionales IHEI (International Hotels Environment Initiative), *mediante la cual quiere estimular a otras sociedades hoteleras a mejorar su desempeño con relación al medio ambiente. En 1996, la sociedad elaboró un resumen de los progresos alcanzados hasta la fecha; el primer análisis de esta naturaleza publicado por una sociedad hotelera internacional.*

Introduction

In recent years there has been much debate about the relationship between the travel and tourism industry and the environment. Many companies and trade associations have issued examples of good practice to illustrate the positive impact that the travel and tourism industry can have on the environment. With the exception of some airlines, however, the travel and tourism industry has not generally selected to produce formal environmental reports quantifying the level of impact arising from activities.

In 1996, Inter-Continental Hotels and Resorts (IHC) took the decision to produce a review of environmental activities over the last five years as a part of their 50th anniversary celebrations. This review was to provide an overview of the environmental impacts of the company; provide an objective assessment of success in implementing the environmental management programme; quantify improvements in environmental performance; and identify areas in which the company had not achieved its environmental commitments. The review will thus act as a baseline against which future improvements in environmental performance can be assessed.

Inter-Continental Hotels and Resorts is the first international hotel company to undertake to produce such a public review, and in so doing throws its operations open to public scrutiny. It hopes that its actions will encourage other travel and tourism companies – and especially those in the hotel sector – to report on their own environmental performance, thus fulfilling one of the key recommendations made in Agenda 21.[1]

The evolution of environmental management at Inter-Continental Hotels and Resorts

Inter-Continental Hotels and Resorts was one of the first international hotel companies to develop a comprehensive approach to environmental issues across all of its owned and managed facilities worldwide.[2] In 1991, the company made this approach public by integrating its environmental commitments in its mission statement to "establish Inter-Continental as the leading and preferred hospitality company by the year 2000. This will be achieved through consistent improvements in the commercial and leisure services provided to the global business traveler. The company aims to achieve this goal while consistently enhancing returns for stakeholders, and preserving the ethic of being an environmentally conscious corporation and responsible employer."

To ensure fulfillment of this mission statement, an assessment was undertaken of the key environmental impacts of the company worldwide. This assessment resulted in the development of the six-point environmental commitment which laid out the company's long-term objectives in the areas in which it could make the most significant improvements in environmental performance. An Environmental Reference Manual was also published focusing on the environmental issue areas in which the company had an impact (waste management and procurement; indoor air quality; energy use; air emissions; noise; hazardous materials; PCBs, asbestos, pesticides and herbicides; water consumption and waste water management; community action).[3] The Environmental Reference Manual specifies a series of actions which can be taken in each area identified – in all, 134 actions are identified. Individual hotels are required to report progress in implementing these 134 actions to head office on an annual basis by completing a checklist. In addition to the checklist, specific and quantifiable targets have been set in areas such as energy, waste, and water management since 1994. The performance of individual hotels in achieving these targets is closely monitored through a system of internal reporting and auditing. The company's financial audit team verify the results reported by hotels in all areas of the checklist, and achievement of targets, on an annual to 18-month basis.

In 1996, the company undertook to develop and publish a review of its environmental performance as the next logical step in its environmental management programme. This review formed a part of the 50th anniversary celebrations and confirmed the company's commitment to communicating its environmental achievements to stakeholders. In publishing such a review, the company wanted to illustrate progress to date and encourage other companies in the sector to adopt comprehensive environmental programmes which would bring about overall improvements in destination quality.

Producing the environmental review

The environmental management system requiring each individual hotel to report progress in implementing the 134-point checklist was essential in developing the environmental review. This data enabled an objective assessment of the number of actions which had been completed in each of the environmental subject areas identified by the manual. This data also highlighted key achievements and weaknesses, thus enabling an assessment of which regions were performing particularly well and those which recorded disappointing results for certain issues.

The process of setting quantified targets, introduced in 1994, provided more detailed data on a global basis for specific issues such as energy and water management. This data forms an excellent basis from which to measure future performance.

The World Travel & Tourism Environment Research Centre (WTTERC) was responsible for writing the review, using the data provided by Inter-Continental Hotels and Resorts. The review explains the approach taken to environmental management at Inter-Continental Hotels and Resorts and reports the results of the environmental management programme within the framework of the six-point environmental commitment. The review reports areas in which the company's environmental programmes have been particularly successful and those in which performance had been disappointing.

Inter-Continental Hotels and Resorts Six Point Environmental Commitment

Inter-Continental Hotels and Resorts strives:

- **to conserve natural resources and energy in its hotels without sacrificing safety standards or jeopardizing guest satisfaction**
- **to select only products from environmentally responsible sources whose use – wherever possible – has positive and beneficial effects**
- **to minimize and efficiently manage waste production, ensuring least possible negative impact on the environment**
- **to acknowledge regional differences in environmental needs and practices by establishing adaptable local programmes designed to improve the performance of each individual hotel**
- **to identify ways to participate in local community action on the environment worldwide**
- **to develop awareness of environmental issues internally and externally through a variety of education and training initiatives.**

The review illustrates that the company's environmental management programme has been very successful in some key areas. For example:

- Over the seven-year period 1988-1995, the company has cut overall energy costs by 27 per cent, exceeding each of the successive annual performance targets. Results from 1995 show the greatest success, with the highest reductions in energy reduction ever achieved – a total saving of US $3,700,000 which equates to a 10,670 kg reduction in sulphur dioxide emitted into the atmosphere.
- Achievement of savings in water and sewage costs in 1995 exceed those in any year since the introduction of the programme. A reduction of 610,866 cubic metres of water was achieved, or an average 6.6 per cent reduction in consumption of fresh water for each of 87 hotels, despite higher occupancies. The total savings are $855,000 in sewerage costs and $240,000 for water heating.
- An Environmental Product and Purchase List was introduced to German hotels. This list identifies more than 500 non-food and beverage products which are used regularly, and targets many of them for eventual replacement with more environmentally benign alternatives, or for reuse or recycling.
- A comprehensive worldwide system was introduced to record, monitor and develop replacement programmes for chlorofluorocarbon (CFC) refrigerants. Seventy-three hotels have now completed a detailed inventory of CFC-containing refrigerant equipment.
- Staff have been motivated to become involved in the programme. The company's "hands-on" approach to environmental issues has been extremely successful, with both a top-down and a bottom-up approach now involving some 50 per cent of the company's 40,000 staff in environmental programmes.

The company has been less successful at:

- measuring the exact volume of waste produced in hotels worldwide. Without such measurement criteria, it has been difficult to assess the company's success at reducing waste volume, although success in implementing the checklist actions in this area indicates a likely reduction in total waste volumes;
- involving all hotels in some regions, especially in areas of low environmental awareness;
- bringing head office facilities into the programme.

Lessons learnt

Overall, the process of producing the review has helped Inter-Continental Hotels and Resorts to make adjustments to its environmental programme from which greater success can be achieved in future years. The review has highlighted the considerable success in some areas, especially as regards the systematic approach which has been applied to energy and water management. This systematic approach will now probably be adapted and applied to other areas of the company's programmes, such as waste management. Areas of disappointing performance or weakness in the management system have also been highlighted, and many have been targeted for action in 1996. The review has also provided a comprehensive benchmark against which future performance can be measured and success assessed.

While the review illustrates overall achievements, the nature of the document makes it difficult to present the relative importance of issues within their local context. By providing quantitative data on the number of actions completed, the review does not reflect the regional importance of some issues. Water management, for example, is a higher priority in arid regions than in temperate ones. Steps could be taken to weight the relative importance of these issues in any future reporting format.

Some issues are not easy to report in the quantifiable format which is generally anticipated for an environmental review. Community programmes are an extremely important element of the IHC environmental programme and have been a great source of inspiration to staff and of interest to guests. Quantifying the relative importance of these programmes, for example in comparison with energy management programmes, has been very complex. There is currently no basis on which the success of such programmes can be assessed.

The review was ambitious from the outset in reporting performance globally. Companies have more commonly reported progress from one site or one country of operation when compiling reviews of activity. The development of such a global review was only made possible by the success of the environmental management system operated by the company and the great enthusiasm of staff worldwide. Global reporting did, however, gloss over some of the issues which are regionally significant and which have been tackled by the programme, but which are relatively unimportant in the global context. Reporting results at a global level means that external auditing of facilities has not been feasible. (Checks have instead been made by the Inter-Continental Hotels and Resorts internal financial audit team.) The exercise in itself, however, indicates the importance of activities in all of the locations in which Inter-Continental Hotels and Resorts operates worldwide. It is an important step in taking reporting from a developed country activity.

Finally, it was not possible to report everything within the review and keep it to a length and style which is useful in the public domain. By necessity, therefore, some elements of the company's programme have not been reported despite significant progress by some hotels in the company in implementing programmes in these areas.

Conclusion

Developing an environmental review has been a constructive and informative process for IHC. It has helped to improve understanding throughout the environmental management team of the considerable success achieved by the programme. The review provides an essential baseline for monitoring future progress. It will hopefully provide the impetus for other hotel companies to review and report on their activities, thus bringing about a baseline from which the impacts of this essential sector of the travel and tourism industry can be measured.

For a copy of the Inter-Continental Hotels and Resorts Environmental Review, contact:
Melanie Baker, Director of Communications,
Inter-Continental Hotels and Resorts
Devonshire House
Mayfaire Place
London W1X 5FH, UK
Fax: +44 (171) 355 6592.

Notes

1. Agenda 21 is the blueprint for securing the sustainable future of the planet agreed by 182 governments at the United Nations Conference on Environment and Development, the Rio Earth Summit.
2. A small number of newly acquired properties which are owned or under management contract with IHC had not adopted a structured approach to environmental issues at the time of writing the review.
3. This Environmental Reference Manual was to become the impetus for the development of the International Hotels Environment Initiative.

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TOURISM NEWS

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Black Sea Tourism Conference

Sustainable tourism in the Black Sea region was the focus of a conference convened by the Global Environmental Facility Black Sea Environmental Programme and held 2-4 May 1996 in Yalta, Ukraine. Representatives from the tourism industry in six Black Sea countries presented country case studies on key issues and on barriers to sustainable tourism, and identified areas where regional solutions were needed. Discussions were also held on the diversification of the tourism industry. Recommendations where made on three major themes: government planning mechanisms and cross-sectoral development, industry cooperation at the regional level, and tools to facilitate the implementation of environmentally sound tourism projects.

Background documents on the Black Sea Tourism Initiative and on the conference are available from: Global Environmental Facility Black Sea Environmental Programme Coordinating Unit, Dolmabhace Sarayi, 11 Jlarekat Kosku 80680 Besiktas, Turkey. Fax: +90 (212) 227 99 33.

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Publications

Réhabilitation touristique des sites délaissés – Guides de Sensibilisation

Recognizing the environmental and economic viability of using existing building infrastructure rather than systematically building new tourism facilities, the French Ministry of the Environment has published this guide to promote the renovation and conversion of existing infrastructure and sites for tourism.

The use of existing facilities is considered under four sections – overall destination development, the conversion of historical and industrial sites for tourism use, the creation of tourism accommodation in buildings of historical and architectural value, and bringing added tourism value to natural sites. Case studies are provided under each section. (The guide is only available in French.)

For more information, please contact: Ministère de l'Environnement, Direction de la Nature et du Paysage, 20 avenue de Ségur, 75007 Paris, France. Fax: +33 (1) 42 19 19 80.

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Two Way Track Biodiversity Conservation and Ecotourism: An investigation of linkages, mutual benefits and future opportunities

The need for an integrated approach for tourism development and biodiversity conservation has been well recognized in Australia. Apart from the National Ecotourism Strategy, all states and territories have produced policy documents on tourism and have started to assess the state of their environment in relation to biodiversity conservation.

This publication explores several mechanisms for integrating biodiversity conservation, ecotourism, and nature-based tourism, and makes

recommendations on a range of issues including the integration of conservation and tourism on private land, changes needed in information systems, education, marketing and bio-regional planning. Monitoring of environmental impacts and visitor attitudes are also discussed.
Biodiversity Series, Paper No. 5. Published by the Department of Sport and Territories, Biodiversity Unit, GPO Box 787, Canberra ACT 2601, Australia. ISBN 0 642 22697 0.

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Tourism, Leisure, Nature Protection and Agri-tourism: Principles, partnerships and practice

This workbook is published by European Partners for the Environment (EPE). It provides recommendations on environmental policies, integrated management and environmental decision-making, environmentally responsible tourism products, marketing and eco-labelling, training, influencing suppliers, energy, water, and waste management, transport, siting and design, visitor behaviour, and information technology.
For more information, please contact: EPE Liaison Office, Ecotopia, Antwerpsesteenweg 461, 2390 Westmalle, Belgium. Fax: +32 (3) 3092874.

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New Issues of the Green Hotelier

The International Hotels Environmental Initiative (IHEI) has published two further issues of the quarterly magazine the *Green Hotelier*. Waste Management – Reduce, Reuse, Recycle and Rethink was the focus of No. 2, while No. 3 focused on Energy.
For more information, please contact: The International Hotels Environmental Initiative, 15-16 Cornwall Terrace, Regents Park, London NW1 4QP, United Kingdom. Fax: +44 (171) 467 3629.

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Calvià Local Agenda 21

The Spanish Ministry of Commerce and Tourism and the Local Government of Calvin, Majorca, Balearic Islands, have published "Calvià Local Agenda 21", a report on the "Development and Sustainability of Aging Tourist Resorts of the Mediterranean Coast: the Case of Calvià in Majorca".

The first part of the document discusses the consequences of declining tourism in the Mediterranean and presents the tourism and environment related problems of this region. The second part presents a programme of action for sustainable tourism development. It includes local approaches being used in other European towns and cities to help implement Agenda 21.

An education pack for teachers on coastal environment issues has been produced within the framework of this initiative.
For more information, please contact: Ajuntament de Calvià, Can Vich 29, 07184 Calvià, Mallorca, Spain. Fax: +34 (71) 139148.

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Catering Management in Africa

This guide provides caterers and supervisors of institutional kitchens in Africa with information on hygienic and efficient kitchen management. It contains action check-lists on good practices in many areas, including fuel choice, hygiene and safety, menu selection and food purchase, food preparation and storage, stock control, and waste disposal. The guide is published by the Bellerive Foundation with support from UNEP.
For more information, please contact: UNEP, Education and Training Unit, UNEP Headquarters, PO Box 30552, Nairobi, Kenya. Fax: 254 (2) 226 831.

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World News

Denmark – a new direction in energy and environmental policy

In a new policy plan, "Energy 21", the Danish Minister of the Environment is proposing changes in Denmark's tax base to encourage energy saving. Under the plan, taxes are no longer calculated on the basis of work but rather on energy consumption. After increases in 1995, Denmark is already amongst the countries with the highest levels of ecologically relevant consumption taxes.

The major source of energy in Denmark is coal-fired power stations, which means the country has high CO_2 emissions. The Energy 21 plan aims to reduce these emissions to half of 1990 levels by 2030. This will be achieved by increasing the proportion of energy from renewable sources, to eventually provide one-third of the country's energy requirements. Additional wind turbines are to be installed, both offshore and along the coast, as part of the Energy 21 plan. Taxes on fossil fuels, introduced in Denmark at the time of the oil crisis in 1973, make alternative energy sources economically interesting.

Goals have also been fixed in the waste management sector. An "Environmental Protection Act" aims to substantially reduce the amount of solid waste produced by the year 2000. Only 15 per cent of the total amount of solid waste is to be landfilled by that date and the recycling rate is to be increased to 30 per cent in the same period. There are plans to introduce separate collection of compostable and non-compostable wastes in 1997.

Riso National Laboratories
Box 49, DK-4000 Roskilde, Denmark
Tel: +45 (46) 32 22 88
Fax: +45 (46) 32 19 99

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International Network of Basin Organizations – first General Assembly and a Technical Seminar

Adequate water management is a key element of sustainable development. It is in this context that the International Network of Basin Organizations (INBO) held its first General Assembly in Morelia, Mexico, on 27-29 March 1996. The network, comprising 68 institutions from 32 countries, was formed in 1994 to encourage a global and integral approach to the management of water resources. It provides a forum for exchanges of information between river basin organizations throughout the world

The "Declaration of Morelia", adopted by INBO delegates at the general assembly, states that they will undertake to control natural disasters such as flooding, drought or the risk of erosion by appropriate management; meet the needs of urban and rural populations for good quality drinking water; help to ensure adequate food supplies by improved drainage and irrigation; promote harmonious development between industry, energy production, recreational activities and waterway transport; and prevent pollution of all kinds in the interests of conservation of aquatic ecosystems.

The General Assembly also emphasized the importance of databases, which must be complete, reliable and easily accessible if they are to be an effective tool for management of water resources. Database compilation and management were the themes of the one-day Technical Seminar, "Information Necessary for Decision-Making", held on 28 March 1996. The seminar's deliberations resulted in a set of recommendations to ensure that database users have access to complete, representative and reliable data on:

- the state of surface and groundwater resources,
- the situation concerning biotopes and the aquatic media and their degree of sensitivity,
- water utilization (withdrawals), with particular emphasis on drinking water supplies and pollution sources,
- the risks of recurring extreme phenomena such as floods, drought or accidental pollution.

For more information, contact Mr Donzier, Secrétariat Permanent du RIOB, Office Internationale de l'Eau, 21 rue de Madrid, 75008 Paris, France. Tel: +33 (1) 44 90 88 60, Fax: 40 08 01 45.

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Green Purchasing Network launched in Japan

A Green Purchasing Network (GPN) was launched in Japan in February 1996. The network is a coalition of 81 members from industry, government and NGOs; its aim is to encourage purchasing of "greener" products, with a special emphasis on products using recycled materials.

The membership, which at present includes 40 major companies, 20 municipal authorities and 13 environmental and consumer groups, is expected to rise to more than 500 within the year.

The GPN's activities will include an annual survey of its members' purchasing practices, preparation of purchasing guidelines for various categories of products, and the publication of a green purchasing guidebook.

For more information, contact Mr Shigeyuki Hashizume, Japan Environment Association, Tokyo, Japan. Tel: +81 (3) 3508 2651 Fax: 3508 2570

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Six recommendations from Friends of the Earth for sustainability in Europe

As part of its ongoing "Sustainable Development for Europe" campaign, Friends of the Earth held a conference on "Sustainable Europe" in November 1995. The conference was sponsored by UNEP, the European Commission, the Dutch and Norwegian governments, and other international and national bodies. The 140 participants from all over Europe, and from different social and economic sectors, discussed steps needed to bring Europe closer to sustainability.

One of the aims of the "Sustainable Development for Europe" campaign is to assess the availability of "environmental space" for 31 European countries. Measuring environmental space means defining the limits within which a country can consume and pollute and still respect the carrying capacity of the environment. The environmental space concept also implies seeking fair distribution of access to the world's natural resources for present and future generations. Living within their environmental space is essential if countries are to achieve sustainable development. Based on this concept, delegates to the conference came to a consensus view which led to six recommendations. These are summarized below:

Sustainability targets
International, national and local bodies should fix targets for levels of consumption of resources based on the global environmental-space concept.

Quality of life
Current economic indicators do not take account of the effects of social and environmental degradation on people's well-being. If "quality of life" indicators are used, the general well-being of people can be shown to have declined in certain developed countries even though wealth, according to conventional indicators such as GNP, has increased. Quality of life indicators should therefore also be applied.

Green tax reform and sustainable production
Poverty, unemployment and underemployment are problems which must be overcome if sustainability is to be achieved. These problems are the result of inefficient economies in which human resources are under-employed and natural ones are over-exploited. Rewarding and sustainable employment could be achieved by "ecological" tax reform, which means increasing taxes on environmental resources to encourage use of environmentally sound technologies and reducing taxes on labour.

Global cooperation and solidarity
Efforts should be made to halt the traditional flow of resources from South to North by seeking

equitable access to environmental space for all. Developing countries and countries with economies in transition should be encouraged to "leap-frog" the unsustainable western model of development and go directly to sustainability.

Pro-active and responsible business

Business and industry can act without regulations to encourage sustainable modes of production and consumption. Cleaner technologies, products and management practices should be adopted wherever possible, and should be transmitted throughout the world to encourage sustainable patterns of consumption.

Public participation

Sustainable development will require commitment and action on the part of the public, as well as political will, if it is to shape future societies. International, national and local authorities should therefore encourage participation by non-governmental organizations and individuals.

For more information, contact Friends of the Earth Coordinating Group, P.O. Box 19199, 1000 GD Amsterdam, The Netherlands. Tel: +31 (20) 6256547. Fax: 6275602.

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European Energy-from-Waste Coalition seminar – European local authority heads discuss energy from waste

"The existence of environmentally sound energy-from-waste facilities is not a dream for the future – they are already here." This was the message from Professor Vogg, a German energy expert, to 35 local authority heads from all over Europe attending the European Energy-from-Waste Coalition (EEWC) seminar in Stockholm in March 1996. The seminar was also funded by the European Commission's Altener Programme.

Professor Vogg presented the seminar with an analysis showing that emissions of dioxins, sulphur oxides, nitrogen oxides and heavy metals from modern installations burning municipal solid waste (MSW) are so low as to be indistinguishable from background levels. The Professor added that exposure of waste to temperatures of between 900°C and 1000°C produced residual ash which is chemically inert. There is therefore no danger of leaching of pollutants from such residues.

The seminar was also addressed by Professor Porteus of the Open University, UK, who explained that, as well as being a clean method of disposal, recovery of energy from MSW gives a net environmental benefit of 550 kWh of electrical energy for each tonne of waste, energy which would be lost if other disposal routes were used.

Mr Van Belle, President of the EEWC working group, reminded the meeting of the importance of incineration in eliminating pollutants: in particular, more than 90 per cent of dioxins are destroyed in this process.

The local authority heads were then given the opportunity to see this technology in operation during a visit to the Högdalenverket energy plant near Stockholm. This plant, in operation since 1971, burns 220,000 tonnes of household waste per year and provides 130 gigawatt-hours (GWh) of electrical energy and 600 GWh of heat, sufficient to power 85 per cent of the local district heating system.

The EEWC estimates that if all household waste in Europe were burnt for recovery of energy, this source could provide 5 per cent of Europe's domestic electricity needs. At present, incineration facilities only contribute around 1 per cent.

For more information, contact Jane Franklin, Countrywide Communications Ltd., Bowater House East, 68 Knightsbridge, London SW1X 7LH, UK. Tel: +44 (171) 584 01 22. Fax: 584 66 55.

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US Energy Department says world energy consumption is set to rise by 50 per cent by 2015

In a report entitled *International Energy Outlook*, the US Energy Department predicts that world energy consumption will rise by 50 per cent over the next 20 years and that greater use of oil will drive the increase. Oil consumption, which was at 69 million barrels a day in 1995, is expected to rise to 99 million barrels a day by 2015. At this level, oil will remain the dominant fuel worldwide.

Energy demand in developing countries will outstrip that of members of the Organisation for Economic Co-operation and Development (OECD). Between 1995 and 2015, demand will grow by 27 per cent in OECD countries and by 77 per cent in non-OECD countries. The projected increase in world energy demand, about 5 per cent higher than previous estimates, will mainly be due to rapid growth in economies in Asia, especially China, India, South Korea, Indonesia, Thailand and Malaysia.

The increased demand will mainly be met by new discoveries of oil and natural gas, technological advances making larger amounts of these resources recoverable, and increased efficiency of generating plants.

Use of natural gas is likely to increase by 69 per cent by 2015. Gas will be preferred because it is a cleaner fuel and because natural gas-fired electricity generating plants are becoming increasingly economically competitive. Many of the OECD countries, which have pledged to limit greenhouse gas emissions to 1990 levels, will increasingly substitute natural gas for coal as a means of stabilizing emissions. The proportion of world demand met by natural gas is expected to be around 24 per cent by 2015, almost equal to that of coal. However, consumption of coal worldwide is expected to rise by 46 per cent by 2015, most of this amount being used for the generation of electricity.

Globally, nuclear power generation is expected to decline by 6 per cent between 1995 and 2015 as nuclear power plants in the developed countries reach the end of their working lives. However, consumption of nuclear power will rise in countries such as China, India, South Korea and Japan, which are at the start of their nuclear programmes.

Consumption of energy from renewable sources, mainly hydroelectric, will grow 66 per cent by 2015, with some contributions from geothermal, solar, wind and biomass sources. In spite of this gain, the overall contribution from renewables to total energy supply will remain proportionally small, as fossil fuel prices will remain low enough to hinder their expansion.

Due to rising energy consumption, world carbon emissions will be around 54 per cent higher than 1990 levels by 2015. Most of these emissions will occur in non-OECD countries. In fact, non-OECD emissions are likely to be greater than those of the OECD by the year 2000 even though developing countries will still be using less energy. Non-OECD emissions are expected to rise by 2.3 billion metric tonnes to reach 5.5 billion metric tonnes by 2015, about two-thirds of the projected increase worldwide.

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EU Accounting Advisory Forum publishes guidelines on environmental issues in financial reporting

Steps taken to address environmental issues, at national and international levels, are obliging businesses to disclose information about their environmental policies and objectives and about expenses incurred either in pursuit of those objectives or in making provision for environmental risks.

At present, environmental expenditure is often only identified as such in response to a legal obligation to repair an existing situation. Companies are also loath to disclose provisions for contingent environmental liabilities, as they fear that such information may be used against them in lawsuits. To help companies meet the increasing requirement for reporting on their environmental policies in financial documents, the EU's Advisory Forum has prepared guidelines, *Environmental Issues in Financial Reporting*, for incorporating environmental expenses and risks into accounting and reporting procedures. These guidelines do not seek to impose new requirements. The aim is rather to give guidance so that better insight can be gained into companies' attitudes to the environment and the impact of environmental risks and liabilities on their financial position.

The document is published by the European Commission's DG XV (Internal Market and Financial Services). Fax: +32 (2) 299 47 45.

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Industry Updates

International Road Transport Union – A Charter For Sustainable Development

Mr J. Hobbs, Coordinator of UNEP's Cleaner Production Programme, represented UNEP at the 25th World Congress of the International Road Transport Union (IRU) held in Budapest 22-25 May, 1996. After the Congress, the IRU published a Charter for Sustainable Development, reproduced below.

For more information, contact International Road Transport Union, 3 rue de Varembé, P.O. Box 44, CH-1211 Geneva 20, Switzerland. Tel: +41 (22) 918 27 00, Fax: 918 27 41.

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WFEO – Strategic Plan and Action Plan

The General Assembly of the World Federation of Engineering Organizations (WFEO) recently approved a Strategic Plan and Action Plan. These plans set out long-term objectives for the WFEO in areas including sustainable development, engineering education, dissemination of information, and the creation of equal opportunities.

For more information, contact WFEO Secretariat, 1/3 Birdcage Walk, London SW1H 1JJ, UK. Tel: +44 (0171) 222 7512, Fax: 222 0812.

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IRU CHARTER FOR SUSTAINABLE DEVELOPMENT

Pursuant to Agenda 21 – the comprehensive blueprint for securing a sustainable future adopted by 182 governments at the United Nations Conference on Environment and Development (UNCED) Earth Summmit – and in particular to Chapter 27 on strengthening the role of non governmental organisations as partners in achieving sustainable development, as well as Chapter 30 on strengthening the role of business and industry, the International Road Transport Union, representing road transport of goods and passengers for hire and for own account in 64 countries on the 5 continents, subscribes, along with its member Associations and affiliated companies, to the principles and commitments detailed below to ensure that road transport plays its just role in the global quest to achieve sustainable development.

Sustainable development has been broadly defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. For road transport, this translates into the challenge of satisfying market demand with the lowest environmental and economic costs possible.

In light of the above, the IRU and its member Associations are convinced that the best policy to protect the environment is to reduce the use of resources and their waste, polluting emissions (gaseous and noise), and fuel consumption, at the source.

CONSIDERING THAT:

- road transport, like every transport mode and human activity, pollutes;
- road transport realises its responsibility to provide the cleanest, quietest, safest and most efficient service possible while recognising that its clients, responding to consumer trends and market demand, have the greatest influence on transport flows;
- noteworthy environmental results have already been accomplished in passenger and goods road transport which, despite increasing volumes, will lead to further significant reductions in polluting emissions, waste, and resource consumption through technical improvements, driver training and more efficient operations;
- transport safety is a key environmental issue;
- government, at all levels, should continuously encourage needed infrastructure development, professional training, and technical improvements in the logistic/transport chain, in co-operation with road transport associations and individual transport companies, and self-regulatory measures aimed at achieving sustainable development in road transport;
- economic development is dependent on an efficient passenger and goods road transport system.

THE IRU, ITS MEMBER ASSOCIATIONS AND AFFILIATED TRANSPORT OPERATORS UNDERTAKE TO:

WORK TOGETHER TOWARDS THE COMMON GOAL OF SUSTAINABLE ROAD TRANSPORT

- encourage the development of long term co-operation and common goals between governments, national Associations and fleet operators aimed at improving environment and energy efficiency, as well as road safety, by each part fulfilling its respective responsibilities;
- call upon all road transport users and partners (road builders and maintenance companies, vehicle and equipment manufacturers and petroleum companies), as well as road transport clients and their intermediaries, to co-operate to reduce road transport pollution at the source, and all governments to urgently provide sufficient infrastructure to ensure that industry measures to achieve sustainable development will not continue to be hampered by inadequate infrastructure and make certain that existing infrastructure capacity will not be threatened by future demographic developments;
- co-operate with public consumer and labour groups as well as the private sector to develop educational and research programmes to help raise awareness and understanding of road transport's important role in achieving sustainable development;
- support the implementation of all non-discriminatory legislation which would effectively achieve sustainable transport at the lowest economic cost;
- promote, where competitive, the use of intermodal transport services;
- support the internalisation of infrastructure costs of all modes of transport;

IMPLEMENT ROAD TRANSPORT OPERATIONS WHICH RESPECT THE ENVIRONMENT AND OTHER ROAD USERS

- study industry and road transport developments with a view to promoting environmentally sound company policies, programmes and performance, taking into account technical developments, scientific understanding, community expectations and client's needs, and establishing quantifiable performance measures and targets to track progress;
- undertake measures to assure optimal fleet maintenance and to verify the proper functioning of vehicles with the objective of remedying immediately any perceived abnormalities to optimise road safety and energy savings and reduce polluting emissions;
- instruct and train personnel to conduct their respective daily activities professionally, in an environmentally responsible manner, such as minimising use of all resources and their waste and, moreover, employing the appropriate driving techniques and best logistics strategy (optimise choice of vehicle, itinerary, etc.) to assure optimum security for themselves and other road users as well as to limit polluting emissions and fuel consumption.

Global trends in motor vehicle pollution control

Steady progress is being made in reducing certain air pollution problems arising from vehicle use, as innovative solutions are found throughout the world. In places where the focus on environmental protection is strong, excellent results can be achieved.

At present there are two main areas of concern: particulates and increasing carbon dioxide emissions. Information on the effects of particulates on health is causing increasingly strong worry, and road transport is one the few sectors in which carbon dioxide emissions have been increasing in recent years.

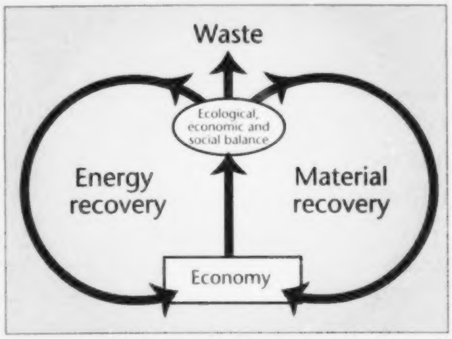
The graphs and charts below, reproduced with the kind permission of Mr M. Walsh, indicate some global trends for the motor vehicle industry.

For more information, contact Michael P. Walsh, Car Lines, 3105 N. Dinwiddie Street, Arlington, Virginia 22207, USA. Tel: +1 (703) 241 1297, Fax: 241 1418, E-mail mpwalsh@ipg.apc.org ◆

R'97 Congress and Exhibition

Geneva

4-7 February 1997



The R'97 Congress, to be held in Geneva 4-7 February 1997, is the follow-up to the R'95 Congress, an event which covered all aspects of Integrated Resources Management (IRM). The R'97 Congress is organised by the Swiss Federal Laboratories for Materials Testing and Research, the Laboratory for Testing and Material Science, and ORGEXPO, with UNEP acting as one of the major sponsors. The congress will include presentations, a poster exhibition and workshops, giving delegates the opportunity to discuss a wide range of topics relating to the latest developments in waste management and recovery technologies. Space will be provided for material technology and other industrial sectors to arrange their own events. Congress delegates will be practitioners and decision-makers from both the public and private sectors. Presentations will be in English, French and German, with simultaneous translation.

For more information, contact LPM Ltd., c/o EWI Ltd., Ms Maria Buhler, R'97 Project Manager, P.O. Box, CH-8034 Zurich, Switzerland. Tel: +41 (1) 385 29 29, Fax: 385 26 53.

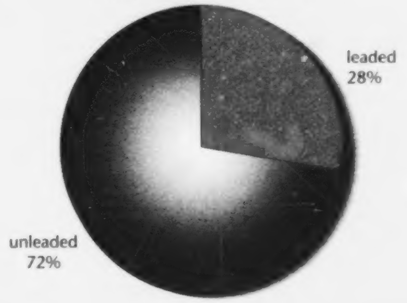
Global trends for the motor vehicle industry

WHO recommended air quality guidelines for Europe

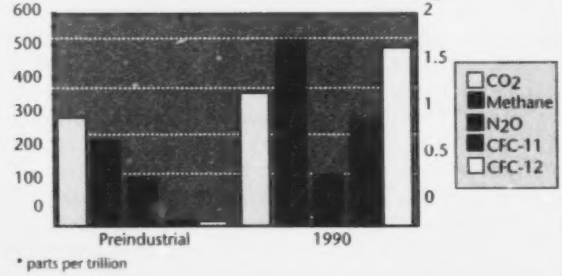
Compound	Guideline value	Averaging time
Ozone	120 µg/m3	8 hours
Nitrogen dioxide	200 µg/m3	1 hour
Nitrogen dioxide	40-50 µg/m3	Annual
Sulphur dioxide	500 µg/m3	10 min
Carbon monoxide	100 mg/m3	15 min
Carbon monoxide	60 mg/m3	30 min
Carbon monoxide	30 mg/m3	1 hour
Carbon monoxide	10 mg/m3	8 hours
Particulates	No threshold	

Unleaded gasoline is becoming dominant

1995 gasoline sales worldwide

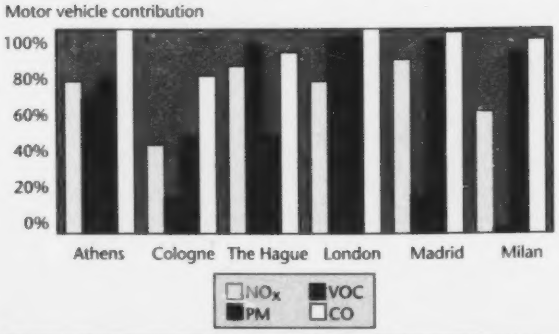


Global atmospheric concentrations of greenhouse gases - PPM



* parts per trillion

Global atmospheric concentrations of greenhouse gases - PPM



UNEP Focus

World Environment Day: environmentalists receive the UNEP Global 500 award

In May 1996, UNEP announced that it was recognising the work of 21 environmentalists and environmental groups by electing them to the UNEP Global 500 Roll of Honour. Recipients of the award were officially honoured on 9 June 1996 at a special ceremony held in Istanbul. The event, hosted by UNEP and the Turkish Parliament during the Habitat II Conference, was part of this year's World Environment Day celebrations.

Among the laureates whose work was honoured at the ceremony was Ken Saro-Wiwa, who led the resistance of the Ogoni People against the pollution of their homeland in Nigeria. Ken Saro-Wiwa and eight other activists were executed by the Nigerian government for their activities in November 1995.

Others honoured include Professor Paul Crutzen, who was awarded the Nobel Prize for his work on depletion of the ozone layer, and, from the industry sector, Ms Tatyana Fyodorovna Stepanenko.

In 1975, Ms Stepanenko began working for the state-owned enterprise Vodokanal in St. Petersburg, where she sought ways of limiting levels of uncontrolled dumping of waste into the Newa River system. This was a challenging task: environmental protection was low on the list of political priorities and the defense industry, source of much of the waste, was not obliged to comply with the few environmental regulations in place. Ms Stepanenko persevered for 18 years before establishing an information collection system recording the dumping of industrial waste. Her findings prompted the government to draft regulations for industry, including supervisory measures and a system of fees based on the Polluter Pays Principle. The policy Ms Stepanenko helped develop is now in force in all Russian townships.

Tatyana Stepanenko, now director of Vodokanal, organizes seminars for industry on the protection of seas and waterways

For more information, contact Global 500 Award, United Nations Environment Programme, P.O. Box 30552, Nairobi, Kenya. Tel: +254 (2) 623 401, Fax: 62 3692/62 3927.

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A CD-ROM on chemical safety from UNEP, ILO and WHO

Chemicals are a vital part of our lives. However, if they are misused they can endanger health or damage the environment. Information about the dangers chemicals may present is essential if they are to be used safely, and this information must be widely available. People at all levels, from decision-makers in government departments to users, require information relevant to their concerns. This was the reasoning which led to the publication in May 1996 of a CD-ROM containing data from the International Programme on Chemical Safety (IPCS). The programme is a UNEP/ILO/WHO joint venture.

The CD-ROM includes the following collections of documents:

- environmental health and criteria monographs,
- health and safety guides,
- data sheets on pesticides,
- toxicological evaluations of pesticides,
- toxicological evaluations of food additives and contaminants,
- toxicological evaluations of residues of veterinary drugs in foods,
- poisons information monographs,
- antidote monographs,
- ChemData database,
- International Register of Potentially Toxic Chemicals data profiles,
- OECD Screening Information Data Sets.

The tens of thousands of pages on the CD-ROM are organised so that any document or section can be accessed easily. A retrieval software, operating with Microsoft Windows, is used to search for words or phrases within a document or on the entire CD-ROM so that specific information about chemicals can be located quickly. Once found, data can be viewed, printed or transferred between documents.

A network version is available, compatible with most popular network operating systems such as Novell and Windows for Workgroups.

Minimum hardware requirements are: 386 IBM-compatible computer with hard disk and at least 4 Mb of RAM, a Super VGA monitor, DOS version 3.1 or greater, Microsoft Windows version 3.1 or greater, CD-ROM drive with CD-ROM interface card and cable, Microsoft CD-ROM Extensions software, Windows-compatible mouse.

For more information and/or order form, contact International Programme on Chemical Safety (IPCS), World Health Organization INCHEM Project, CH-1211 Geneva 27, Switzerland. Tel: +41 (22) 791 3590, Fax: 791 4848.

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UNEP guidelines on biotechnology safety

UNEP has published the International Technical Guidelines for Safety in Biotechnology, to be used as an interim instrument while awaiting a protocol from the Working Group of the Conference of the Parties to the Convention on Biological Diversity. It is expected that the protocol will take several years to prepare.

The potential contribution from biotechnology to sustainable development, through improvements in food production and health care, is recognised in Agenda 21, adopted at the 1992 UN Conference on Environment and Development. However, it is also recognised that there are risks for biodiversity resulting from the use and release of modified, living organisms produced using the techniques of biotechnology. The purpose of the UNEP Guidelines is to aid governments, and all other interested parties, in assessing and managing those risks.

The Guidelines stress that the resources and capacities required to control the risks from biotechnology are not available or are inadequate in many countries. Emphasis is therefore placed on "capacity-building", defined as "the strengthening and/or development of human resources and institutional capacities". In addition to presenting the principles of risk control, the 30-page booklet also contains annexes which identify specific areas of concern and give examples of risk management measures for controlled release of organisms.

World Environmental Congress – WORLD 96

The World Environmental Congress ("*WORLD 96*") will be held 26-29 October 1996 in Cincinnati, Ohio, USA, sponsored by the Air and Waste Management Association (AWMA), the University of Western Ontario (UWO), the United Nations Environment Programme (UNEP), and the US Environmental Protection Agency (EPA).

The purpose of the Congress is to bring together experts from industry, academia and governments with the intention of promoting environmental science, technology and business. *WORLD 96* is designed to be of interest to those involved in the research, development, demonstration and commercialization of innovative and conventional technologies for pollution prevention and the control and remediation of contaminated water, air, soil, sediments or sludge media.

The congress is being held in conjunction with two other events: the Third International Conference on Advanced Oxidation Technologies for Water and Air Remediation, and the Second International Conference on TiO_2 Photocatalytic Purification and Treatment of Water and Air.

For more information, contact Dr Hussain Al-Ekabi, Science and Technology Integration, Inc., UWO Research Park, Suite 110, 100 Collip Circle, London, ON N6 4S2, Canada. Tel: +1 (519) 858 5055, Fax: 858 50 56.

For more information, contact UNEP, P.O. Box 30552, Nairobi, Kenya. Tel: +254 (2) 623258/59, E-mail: hamdalla.zedan@unep.no ◆

UNEP Chemicals – catalysing global action

UNEP Chemicals is the focus for all of the activities undertaken by UNEP to ensure sound global management of hazardous chemicals. UNEP Chemicals' team of professionals, based in Geneva, uses the solid technical foundation of the International Register of Potentially Toxic Chemicals (IRPTC) to assist countries in building capacities for safe production, use and disposal of chemicals and to facilitate, or "catalyse", global actions to reduce or eliminate chemical risks.

Capacity-building goals are achieved in two ways: by providing information and information tools, and by working directly with countries to build their capacities. UNEP Chemicals Information is available in a variety of forms, including published documents and the IRPTC's databank, which provides extensive safety data on over 8,000 chemicals and is usable on a personal computer. Direct work with countries includes awareness-raising exercises, training, and "hotline" support for governments.

UNEP Chemicals' most important ongoing actions for 1996 are:

- facilitating development of a legally binding instrument for the application of the Prior Informed Consent (PIC) procedure;
- promoting the development of recommendations for global action on Persistent Organic Pollutants (POPs);
- convening a group of government-designated experts to further measures to reduce the risk from a number of hazardous chemicals.

For more information, contact Mr James B. Willis, Director, UNEP Chemicals (IRPTC), 15 Chemin des Anémones, Case Postale 356, CH-1219, Châtelaine, Geneva, Switzerland. Tel: +41 (22) 979 9111, Fax: 797 3460, E-mail: irptc@unep.ch ◆

UNEP IE activity summary

UNEP IE works on a wide range of issues through several distinct Programmes. A number of the Programmes produce their own quarterly or biannual newsletter, describing their work in more detail. For more information on all activities mentioned, contact UNEP IE.

Awareness and Preparedness for Emergencies at Local Level (APELL) Programme

The consultative version of "APELL for Port Areas", published jointly by IMO and UNEP, is now available in English, French and Spanish. An outline of the issues addressed in the report is given below.

APELL for Port Areas

A new document to help port authorities to prevent and respond to technological accidents

It has long been recognized that port areas represent a complex interface, between land and sea, between human activities and the natural environment and between different transport modes. They have unique safety and environmental protection problems and need well-integrated environmental emergency plans. The International Maritime Organization (IMO) and the UN Environment Programme Industry and Environment centre (UNEP IE) have now joined together to help all those with responsibility for port safety to improve prevention of technological accidents – and to improve awareness and preparedness to respond to them should they nonetheless occur.

UNEP IE launched its Awareness and Preparedness for Emergencies at Local Level (APELL) programme in 1988. APELL's goals are to prevent technological accidents and, failing this, to minimize their impacts. This is achieved by assisting decision-makers and technical personnel to increase community awareness of hazardous installations and to prepare co-ordinated emergency plans involving industry, government and the local community, in case unexpected events at these installations should endanger life, property or the environment. The APELL Handbook sets out a 10-step process for doing this.

APELL was originally developed for land-based fixed installations. However many APELL users have requested specific guidance in relation to port areas. Many of IMO's conventions, agreements, regulations, manuals and other guidance documents have great relevance to shipping operations in port areas, including comprehensive technical information on contingency planning for emergencies. IMO has been able to gather the views and advice of government and industry experts in the development of this guidance for use in port areas, recognizing that the community surrounding the port may well be affected by accidents within the port area and that emergency plans within and outside the port area therefore need to be co-ordinated and the community informed and prepared.

The process outlined in "APELL for Port Areas" will be tried out through several pilot projects. The document incorporates much of the original APELL Handbook and demonstrates that it can be applied in port areas. However it also provides further guidance in the references annex, which includes technical guides ranging from the recommendations on the safe transport of dangerous cargoes in port areas to the preparation of oil pollution emergency plans for ships and oil handling facilities. This Handbook is to be reviewed by IMO at the 40th session of its Marine Environment Protection Committee in September 1997. Therefore any comments arising from the consultation version are to be submitted to IMO by the end of May 1997. IMO and UNEP hope that all those tackling the problems of emergency preparedness planning in port areas will find the guidance helpful.

The biannual APELL Newsletter is available in English, French and Spanish and is a free of charge supplement to ***Industry and Environment.***

Cleaner Production (CP) Programme

◆ Regional Meetings on Cleaner Production (CP)

In order to develop ideas and consensus on regional perspectives to be presented at the Fourth High Level Seminar on Cleaner Production, to be held in Oxford 23-26 September 1996, three Regional Meetings have been organized.

◆ In Rome on 17 May, a Meeting for the **Mediterranean Region** was hosted by ECOMED, with 30 participants – mostly representing governments, academia and NGOs – from 13 countries.

The Mediterranean region is a microcosm of the world, in the sense that it includes both developed and developing countries and is multicultural. Solutions found to problems in this region may have global replication opportunities. Tourism is a sector of special interest in regard to the introduction of CP approaches.

CP approaches are still in the demonstration phase. The barriers (financial, managerial, technical) to progressing beyond this phase need to be considered. Lack of private sector involvement and the need for local "ownership" were stressed. CP centres in Barcelona, Tunisia and Egypt are the pioneers of CP in the region. These CP centres are mainly established and maintained through donor support programmes, and local ownership is not sufficiently integrated. KOSGEB (an organization providing support to SMEs in Turkey) is an example of an institution that has integrated cleaner production into its existing activities.

◆ In Abu Dhabi on 10-12 June, 35 participants (mainly representing industry) from six countries took part in a Meeting for the **West Asia Region**.

There are some CP success stories, and expertise exists in the region, but on a limited scale. Some of these success stories were presented during the seminar. However there is a lack of appropriate governmental legislation, effective enforcement and implementation systems, and economic incentives. NGO activities are taking place, but have limited support.

◆ On 22-23 August in Bangkok, a Meeting for the **Asian and Pacific Region** was held. There were 40 participants from 12 countries – mostly from governments and academia or consultants.

This region is distinguished by tremendous industrial growth with a high proportion of SMEs, strong industrial development policies and proponants, and broad diversity between countries. But in most countries the CP is donor driven. Generally sound regulations are inconsistently and inefficiently enforced. The focus is on technology rather than mangement. But the ISO 14000 series may be the instrument needed to change this situation.

The biannual CPNewsletter is available in English, French and Spanish and is a free of charge supplement to ***Industry and Environment.***

New coordinator for UNEP IE's Cleaner Production Programme

Mr Jonathan (Jon) Hobbs of the UK took up the post of Coordinator of the Cleaner Production Programme at UNEP IE's Paris office in April of this year.

Although born and educated in the UK, Mr Hobbs has spent the last twenty years of his working life in Africa, first with the University of Malawi and then as Land Use Planning Advisor to the Botswana government. In 1982 he joined the South African electricity utility Eskom, where he rose to become Corporate Consultant (Environmental Affairs). In 1989 he also took up the position of Director of the newly-formed Industrial Environment Forum of Southern Africa and was instrumental in establishing similar business-led associations in Zimbabwe, Namibia, Mozambique and elsewhere. He served on South Africa's delegation to TC 207 of ISO, tasked with formulating the ISO 14000 series of international standards on Environmental Management Systems.

Mr Hobbs has served as Eskom's liaison delegate to the World Business Council for Sustainable Development since 1991 and has been a member of the International Chamber of Commerce's Environmental Committee since 1990, He has published widely on business environmental strategies and has given guest lectures at many business schools and universities.

In 1992, Mr Hobbs led the South African business delegation to the "Earth Summit" in Rio. More recently he has been involved in the negotiating teams incorporating environmental rights and responsibilities into South Africa's new constitution and formulating new national environmental policies and legislation.

The Cleaner Production Programme which Mr Hobbs will coordinate provides a cleaner production information clearinghouse, produces publications, organises working groups, builds capacities through training activities and demonstration projects, and, together with UNIDO, supports setting up of national cleaner production centres.

For more information, contact UNEP IE, 39-43 quai Andre Citroën, 75739 Paris Cedex 15, France. Tel: +33(1) 44 37 14 50, Fax: +33 (1) 44 37 14 74.

Environmental Technology Assessment (EnTA) Programme

◆ **Draft International Guidelines.** UNEP IE has prepared draft international guidelines on technology transfer, for submission to UNEP's next Governing Council Meeting in January 1997. These guidelines address which information technology suppliers or providers should communicate to technology importers or users regarding potential environmental impacts.

◆ **Primer to be used in EnTA training**

Joseph Coates of the Kanawha Institute has prepared a primer on environmental technology assessment for UNEP, entitled "Anticipating the Environmental Effects of Technology". The primer is intended for senior people in government, business and other organizations concerned with technology; it contains a thorough analysis of the steps involved in environmental technology assessment and a workbook with exercises. The primer is now ready for field testing. UNEP's planned workshop on Environmental Technology Assessment in Sub-Saharan Africa (November 1996) should provide an appropriate forum for assessment of its applicability and usability by its target audience.

◆ **Information systems survey presented to CSD, and new UNEP Environmentally Sound Technology Networking Programme launched**

In April 1996 UNEP IE, IETC and INFOTERRA jointly presented the final results of a 14-month "Survey of Information Systems Related to Environmentally Sound Technology" to the Commission on Sustainable Development (CSD). The CSD supported UNEP's work, encouraging it to develop an EST information network to increase compatibility and cooperation among information systems and sources related to environmentally sound technologies (EST).

UNEP IE, located in Paris, and the International Environmental Technology Centre (IETC), located in Japan, recently agreed to merge their technology assessment activities into EnTA in order to provide a more efficient and focused programme.

*The EnTA Newsletter is a free of charge supplement to **Industry and Environment.***

OzonAction Programme

UNEP's 1996 Work Programme, totalling US$3.63 million, was approved by the Executive Committee at its 19th meeting. Six country programmes under the Multilateral Fund (Bahamas, Gambia, Lebanon, Morocco, Papua New Guinea, Viet Nam) were also approved, together with their respective institution-strengthening projects. A training strategy and a paper submitted by UNEP on countries consuming low volumes of ODS (LVCs) were endorsed. Comments were invited on a paper prepared jointly by UNEP and UNDP on small and medium-sized enterprises.

The OzonAction programme organized three Training Workshops on Good Practices in Refrigeration in Colombia on 14-24 May. These workshops were the start of a one-year programme that will train about 8,000 technicians and lead to the creation of a National Refrigeration Council.

A Training Workshop on the Safety Aspects of CFC Substitution was held in China on 22-24 May. It was attended by participants from national and local government, industry, and the National Environmental Protection Agency (NEPA). The workshop's objective was to help local organizations and NEPA to address safety issues by providing information and training.

The ODS Officers Network for French-speaking Africa held its follow-up meeting in Brazzaville, Congo, and the annual workshop for the ODS Officers Network of Latin America was held in Cartagena, Columbia.

The fourth update of the OzonAction Information Clearinghouse diskette, version (OAIC-OV), was produced and disseminated to national ozone units in developing countries as well as to other focal points in developed countries.

The OzonAction Newsletter is published quarterly and is available free of charge from the OzonAction Programme at UNEP IE.

Tourism Programme

See page 57 for news of activities of the Tourism Programme.

Global Industrial Management Programme

UNEP, the International Chamber of Commerce (ICC) and the International Federation of Consulting Engineers (FIDIC) are developing a joint campaign to promote the implementation of environmental management systems in enterprises around the world.

Environment ministers and officials, business executives and environmental organizations took part in a second UNEP/ICC Panel, held on the occasion of the Commission on Sustainable Development in New York. In 1994, the first UNEP/ICC Advisory Panel gave impetus to the development of a training kit, developed by UNEP, the ICC and the FIDIC. Decisions made by the panel mark a major international advance in the campaign to promote environmental management and sustainable production and consumption. Support was agreed upon for national and sectoral adaptations of the UNEP/ICC/FIDIC EMS Training Resource Kit, including an interactive diskette version, and national workshops to support internalization of EMS in small- and medium-sized companies. The ICC and UNEP will also promote the use of voluntary codes of conduct, in particular the ICC Business Charter for Sustainable Development, and will develop further tools to support their implementation.

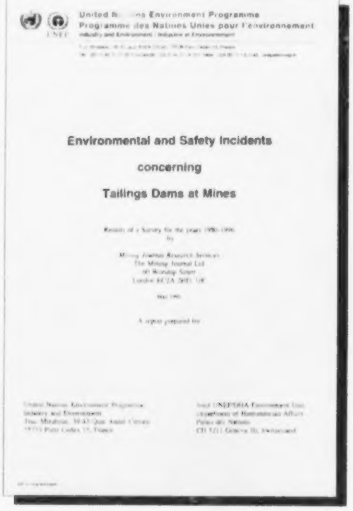
Industrial Pollution Management Programme

The final report on "Environmental and Safety Incidents Concerning Tailings Dams at Mines" was published by UNEP IE, as a limited edition. The report is based on a survey undertaken by Mining Journal Research Services, and was prepared with the cooperation of DHA and OECD. A synopsis of the report is reproduced below.

Environmental and Safety Incidents Concerning Tailings Dams at Mines

On request from UNEP IE and the joint UNEP/DHA Environment Unit, the Mining Journal Research Service has prepared a report on the environmental effects of incidents involving tailings dams at mines.

The tonnage of mine tailings generated around the world each year is very large. For example, world copper production in 1995 resulted in 1,500 Mt of tailings, while gold output generated 500 Mt. 120 Mt of tailings from potash mining were produced.



United Nations Environment Programme
Programme des Nations Unies pour l'environnement
Industry and Environment / Industrie et Environnement

Environmental and Safety Incidents

concerning

Tailings Dams at Mines

Results of a Survey for the years 1980-1996
by

Mining Journal Research Services
The Mining Journal Ltd

A report prepared for

The collation of data concerning tailings dams remains with individual agencies, with wide variation in the amount and quality of information held. Accordingly it is rarely possible to estimate the true number of impoundments, nationally or world-wide. As a guide, respondents reported 350 tailings dams in the State of Western Australia and 164 in the Canadian province of Quebec. For the Republic of South Africa, the estimate is of the order of 400.

Tailings dam embankments are typically (but not universally) constructed from non-cohesive materials such as cycloned tailings, earthfill or waste rock, all of which can easily be eroded by water. Failure of decant systems, spillways and diversion conduits is a major factor in smaller incidents. Inadequately sized spillways or decant systems can also lead to wall failure.

An area for concern continues to be inadequate supervision of construction, as noted by the New South Wales Mine Inspectorate: "In regard to the construction of tailings dams we are concerned that while their design may be adequate their construction may not be to specifications; construction is often performed other than by the designer."

Most failures occur as a result of percolation through the dam wall, internal erosion, overtopping or flooding, and may be triggered by natural phenomena such as earthquakes or persistent heavy rain. Incidents from uncontrolled seepage have become more common with the increased use of cyanide in the recovery of gold in all parts of the world. Dust emissions can also present localised nuisance, such as dust blowing from the Kilembe tailings dams and pyrite stockpiles in Uganda and the cadmium contamination that is emitted from Chinese tungsten mine waste. Bird kills from cyanide are increasingly reported. Fortunately, large-scale incidents are infrequent. This study identified fewer than ten major failures between 1980 and 1996.

Greater importance should be attached to relocation of communities that have a risk of inundation should a tailings dam fail. The fact that the largest number of casualties recorded within the study period were sustained by the general population, and not mining company workers directly, underscores its potential vulnerability.

Overall, the level of public reporting of major failures is very variable. There is no centralised source of information about tailings dam incidents, either internationally or, for the most part, nationally.

The study concludes that tailings dams are a necessary constituent of modern mining practice. Incidents of varying degrees of severity have occurred in the past, and probably will in the future. The task ahead is to ensure that the risk of major incidents is minimized and that environmental impacts be given greater attention. Improvements in design, construction and operating practice will assist in achieving this, with requirements increasingly being stipulated in the relevant regulations.

Environmental and Safety Incidents Concerning Tailings Dams at Mines. UNEP and DHA Environment Unit. Available from UNEP IE.

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UNEP Industry and Environment in the regions

Industry and Environment in Asia and the Pacific

Improving industrial environmental management in pulp and paper production is important in Asia, where it is a significant source of industrial water pollution. Under the NIEM programme, over 30 mills in seven Asian countries are cooperating with government partners in an effort to demonstrate the attractiveness of a preventative, Cleaner Production approach. Demonstration mill assessments are underway in seven countries, with promising results in both improved mill economy and reduced pollution loads. The demonstration phase will conclude with national training workshops conducted for the industry later this year.

ROAP is planning a workshop with the World Bank that would bring together financial institutions and ODS officers in Asian countries for training on technical and policy issues related to the phase-out of ozone depleting substances. The Bank uses "Financial Intermediaries" to help it appraise ODS phase-out investment projects. The workshop will help increase the capability of financial experts working in the FIs.

The World Business Council for Sustainable Development has recently completed an exhaustive study on the sustainability of the paper cycle. The study, conducted on behalf of WBCSD by the International Institute for Environment and Development, examined issues such as fibre supply and forestry practices, mill operations, recycling of waste paper, and energy recovery. ROAP plans to conduct a regional seminar with WBCSD in late 1996 that would give greater exposure to the results of the study and engender debate on its conclusions and recommendations. The ROAP effort would be carried out under the NIEM umbrella.

At the request of the Worldwide Fund for Nature and of UNDP, ROAP recently participated in a workshop for Vietnamese government officials and industry representatives on establishing a Vietnamese business council for sustainable development. The three-day workshop, which took place in Hanoi, explored why establishing such a group might benefit both the government and industry, and how it might be constituted in Vietnam.

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New staff member at ROAP

In evidence of its continued support of improved environmental management in the pulp and paper industry, the Swedish government has seconded an engineer to the Regional Office for Asia and the Pacific. Mr Niclas Svenningsen arrived in Bangkok in early May and is assigned to the Network for Industrial Environmental Management (NIEM) Cleaner Production effort. He is well qualified, having worked for the Swedish Environmental Protection Agency for the past six years. Mr Sveningsen's duties at Swedish EPA included investigating cleaner technologies to determine their potential; collecting, evaluating and disseminating information on production processes; making decisions regarding financial support for cleaner production projects; and generating public awareness of environmental protection. Mr Svenningsen has degrees in civil engineering from the Lund Institute of Technology and in petroleum exploration from Chalmers University of Technology, both in Sweden. We welcome him to ROAP and the NIEM effort.

For additional information on ROAP industry activities, please write: Industry Programmes, United Nations Environment Programme, Regional Office for Asia and the Pacific, United Nations Building, Rajadamnern Avenue, Bangkok 10200, Thailand. Tel: +662 288 1679; +662 288 2128, Fax: 280 3829

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Books & Reports

GENERAL

Survey of On-Site Green Technique in Japan

In 1995, the Global Environment Centre (GEC), a supporting foundation of UNEP-IETC, carried out a survey of on-site green techniques which are techniques developed on-site to reduce waste materials, waste liquids, exhaust gases, noise and vibrations generated by production activities or construction work. The results of this survey are now available in a comprehensive report.

The GEC survey team deliberately concentrated on simple but efficient technical solutions arising from the ingenuity and creativity of people working on site. The resulting report takes the form of a compendium of around 90 such techniques, presented succinctly as one-page summaries. Each summary gives the reasons and objectives for the technique, a description, and the expected results from its application. Subjects range from "recycling of waste oil" to "repeat use of corrugated cardboard for packing of chairs". The emphasis on simple yet efficient techniques makes those presented in the survey especially suitable for transfer to developing countries.

Survey of On-Site Green Technique in Japan (1995). Global Environment Centre Foundation, 2-110, Ryokuchikeon, Tsurumi-ku, Osaka 538, Japan. Tel: +81 (6) 915 4121. Fax: +81 (6) 915 0181. Pbk, 126p.

Taking Action: An Environmental Guide for You and Your Community

Article 10 of the Rio Declaration stated that "Environmental issues are best handled with the participation of all concerned citizens at the relevant level." The last two decades have witnessed a widespread increase in public awareness and understanding of environmental issues, with a growing number of people – ordinary citizens, executives, government officials, religious leaders and journalists – recognising that their long-term aims and activities and environmental conservation are mutually dependent. The UNEP Taking Action guide is intended to provide stimulus to ordinary citizens and communities to overcome obstacles to environmental protection. The guide provides basic facts about the environment, demonstrates how environmental issues affect peoples' lives and proposes alternative solutions based on the best available information.

The first section of the book examines the global nature of environmental problems, the global economy, and the role of communities. This is followed by practical guidance on how to organise for action. A "Community Toolbox" section covers these practical aspects in chapters on "Using the Media", "Fund-Raising and Finding Sponsors", and other related subjects. A second section addresses major environmental issues such as Energy, Waste, and Forests. As in the first section, the emphasis is on action and each chapter ends with a list of practical suggestions for steps which can be taken at both community and individual levels.

UNEP, P.O. Box 30552, Nairobi, Kenya. Tel: +254 (2) 621234, Fax: +254 (2)226886/226890. Pbk, 225p. ISBN 92-807-1568-2.

The Economic Appraisal of Environmental Projects and Policies – A Practical Guide

It is now widely accepted that the path to sustainable development requires better integration of economics into the environmental decision-making process. However, knowledge of the methods of appraisal of environmental projects and policies is generally limited to a small number of specialists. To make these subjects accessible to a wider public, OECD has published a guide to appraisal methods, intended for non-specialists. The guide gives a simplified yet comprehensive overview of economic evaluation techniques, explaining their basic principles, strengths and weaknesses, fields of application and sources of information.

OECD Publications, 2 rue Andre-Pascal, 75775 Paris Cedex 16, France. Pbk, 171p. ISBN 92-64-14583-4.

The Politics of Environmental Discourse

This book investigates environmental policy-making as the socially accepted set of practices through which we try to face what has become known as the ecological crisis. The central argument is that a new way of conceiving environmental problems has emerged since the late 1970's. This "ecological modernization" recognises the ecological crisis as evidence of a fundamental omission in the workings of the institutions of modern society. However, unlike the radical environmental movements of the 1970's, it suggests that environmental problems can be solved in accordance with the workings of the main institutional arrangements of society. Environmental management is seen as a positive-sum game: pollution prevention pays.

The author, Maarten A. Hajer, combines social theory with detailed empirical analysis to illustrate the social and political dynamics of ecological modernization in an analysis of acid rain in Britain and the Netherlands.

The book concludes with a reflection on the institutional challenge of environmental politics in the years to come.

Clarendon Press, Oxford University Press, Walton Street, Oxford OX2 6DP, UK. Hbk, 318p. ISBN 0-19-827969-8.

State of the Environment in Asia and the Pacific

Asia and the Pacific covers a vast geographical area, from Mongolia in the north to New Zealand in the south and from the Cook Islands in the east to Armenia in the west. It also covers a vast expanse of the Pacific and Indian oceans. The range of ecosystems found in the area is accordingly wide and varied, including deserts, forests, rivers, lakes and seas. The region has the world's second largest forest cover and contains two-thirds of the world's coral reefs and one-third of its mangrove areas.

Globally Asia and the Pacific is the fastest growing region in the world in economic terms. However, it is a region of contrasts encompassing established economies, such as Japan and the Republic of Korea, rapidly developing economies, such as China, and some of the world's least developed countries, such as Bangladesh.

These complex and contrasting elements are reviewed in the *State of the Environment in Asia and the Pacific* report, prepared by the Economic and Social Commission for Asia and the Pacific (ESCAP) Secretariat, with support from the Asian Development Bank and the United Nations. The document is more than a simple situation report: its underlying theme is sustainable development. The emphasis is therefore on covering the physical environment, the ecosystems, the development/environment relationship and trends both in the region as a whole and in sub-regions. The report features major areas of concern and the principal challenges and issues for action by governments, intergovernmental organisations, non-governmental organisations and private enterprises in the region.

ESCAP, United Nations Building, Bangkok 10200, Thailand. Tel: +66 (2) 288 1866, Fax: +66 (2) 288 1052. Pbk, 653p.

OECD Environmental Data Compendium, 1995

To address global environmental issues, governments, businesses and concerned members of the public all need harmonised data on the environment. The Environmental Data Compendium, from the Organisation for Economic Co-operation and Development (OECD) provides such data. The Compendium is a regular OECD publication, appearing every two years, which relates data on pollution and natural resources to such areas of economic activity as energy, transport, industry and agriculture. The data are organised so as to give an overview of the present state of the environment, to reflect the pressures on it, and to give information about its management.

OECD Publications, 2 rue André-Pascal, 75775 Paris Cedex 16, France. Tel: +33 (1) 45.24.82.00. Fax: +33 (1) 49.10.42.76. Pbk, 305p. ISBN 92-64-04614-3.

Key Performance Indicators Manual – A Practical Guide for the Best Practice Development, Implementation and Use of KPIs

Key Performance Indicators (KPIs) are defined as "sets of measures focusing on the aspects of organisational performance that are most critical for the current and future success of an organisation." Historically, performance measurement has often been viewed as something imposed by management to be used for its own, frequently undisclosed, purposes. This manual describes an alternative view of measurement, in which it is seen as something understood and owned by employees as well as their managers. In this context, measurement, in the form of KPIs, becomes a tool for empowerment, giving employees the power to effect changes where they need to occur.

After an introduction to the general principles, in the first part, the manual provides practical help in the introduction of KPIs, through a "Workbook" (Part 2) and a "Facilitator's Resource Kit" (Part 3). The resource kit includes overheads for presentations and examples of typical questions likely to arise during introduction of KPIs, together with their answers.

Pearson Professional (Australia) Pty Ltd., 95 Coventry Street, South Melbourne, VIC 3205, Australia. Tel: +61 (03) 9699 5400. Fax: +61 (03) 9696 5205. Hbk (ring file), 167p. ISBN 0-7299-0326-5.

Case Book Series Volume 1: Case studies in Environmental Management in Small- and Medium-Sized Enterprises

Owners and managers of small- and medium-sized enterprises (SME)often fail to implement sound environmental policies because they assume that they will not obtain adequate return on their investment. To help correct this misconception, the International Network for Environmental Management's *Casebook Series* applies the principle that the best way to teach is by example. The *Casebook* accordingly presents a set of case studies demonstrating environmental management in application in a wide range of industrial sectors throughout the world.

International Network for Environmental Management, Bahnhofstr. 36, d-22880 Wedel (Holstein), Germany. Tel: +49 4103 84019. Fax: +49 4103 13699. Pbk, 120p.

Environment Assessment Technical Reports

In 1994 UNEP initiated a programme to support environment assessment, reporting and data management capacities in countries with economies in transition in Central and Eastern Europe. Reports on seminars and workshops on this activity, which is part of UNEP's global Environment and Natural Resources Networking programme (ENRIN), are now available.

For details of workshops, seminars and countries covered, contact: GRID-ARENDAL, Longum Park Technology Centre, P.O. Box 1602, Myrene N-4801, Arendal, Norway. Tel: +47 (37) 03.56.50. Fax: +47 (37) 03.50.50.

TRANSPORT AND ENERGY

Photovoltaics in Buildings – A Design Handbook for Architects and Engineers

Photovoltaic (PV) cells are solid state devices that convert solar radiation into electricity directly. Photovoltaic systems are generally modular in structure, which means that they can be designed to provide power from a few milliwatts to several megawatts. Such flexibility makes this technology a viable solution for a wide range of energy supply problems.

The *Photovoltaics in Buildings* handbook presents PV technology from both the theoretical and practical points of view. The book begins with an introduction to the technology and main system components, such as solar cells and inverters. Once the technology has been explained, detailed case studies show how it can be incorporated into design solutions. The handbook is a comprehensive study of the subject which will help designers, engineers and owners to integrate PV technology into their buildings.

Friedrich Sick and Thomas Erge, eds. James & James (Science Publishers) Ltd., Waterside House, 47 Kentish Town Road, London NW1 8NZ, UK. Hbk, 287p. ISBN 1-873936- 59-1.

Motor Vehicle Emission Regulations and Fuel Specifications in Europe and the United States

This report records changes in European and US laws and regulations governing motor vehicle emissions, fuel specifications and fuel consumption. It details legislation on emissions and emission testing, current proposed vehicle inspection and maintenance programmes and legislation aimed at controlling in-service emissions performance, fuel consumption and CO_2 legislation, plus fuel specifications and characteristics.

Concawe, Madouplein 1, 1210 Brussels, Belgium. Tel: +32 (2) 220 3111. Fax: +32 (2) 219 4646. Pbk, 203p.

IAEA Yearbook 1995

The International Atomic Energy Agency yearbook reports on the agency's activities during 1995 and in the early months of 1996.

Sales and Promotion Unit, International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria. Pbk, 254p. ISBN 92-0-101295.

CHEMICAL POLLUTION & ACCIDENTS

Control of Hazardous Air Pollutants in OECD Countries

The extent of the threat to health and the environment from hazardous air pollutants, at local, regional and global levels, has only recently been identified. This OECD publication examines the seriousness of the problem and the best ways of controlling it.

The book describes the nature and magnitude of the problem, clearly identifying the substances concerned and their sources. Overall policy frameworks and principles applying in OECD countries are discussed, as are some of the economic incentives used in connection with hazardous pollutant control. Reports on the situation in individual countries are included, together with conclusions drawn from them and recommendations for future work.

A companion publication presents the proceedings of a workshop on these pollutants.

OECD Publications, 2 rue André Pascal, 75775 Paris Cedex 16, France. Tel: +33 (1) 45.24.82.00. Fax: +33 (1) 49.10.42.76. Pbk, 235p. ISBN 92-64-14637-7.

Pesticides and the Immune System: The Public Health Risks

There is a significant body of scientific evidence to suggest that many pesticides cause damage to the human immune system. Yet hundreds of millions of farmworkers, farm households and consumers are probably exposed to dangerous levels of pesticides; most of these people live in developing countries or in the former Soviet Union.

Pesticides and the Immune System, from the World Resources Institute, presents some of the scientific evidence, from animal experiments, observations of wildlife and investigations in human populations, for the link between immunosuppression in humans and exposure to pesticides. The report also covers compounding risk factors and gives recommendations for further work.

By Robert Repetto and Sanjay S. Baliga. World Resources Institute, WRI Publications, P.O. Box 4852, Hampden Station, Baltimore, MD 21211, USA. Pbk, 103p. ISBN 1-56973-087-3.

Journal of Advanced Oxidation Technologies

Advanced Oxidation Technologies (AOT) are technologies that involve the generation of highly reactive intermediates (e.g. hydroxyl radicals) that initiate reactions resulting in the destruction and removal of organic pollutants from water.

The *Journal of Advanced Oxidation Technologies*, of which the first issue is now published, prints articles and papers covering developments and research in the field. The Journal is intended for researchers in universities and industry, for professionals involved in implementation of AOTs for pollution control, and for policy and decision makers in government environmental organizations or industry.

Science & Technology Integration Inc., The University of Western Ontario, Research Park, 100 Collip Circle, Suite 110, London ON N6G 4X8, Canada. Pbk. 101p. ISSN 1203-8407.

Hazardous Waste Remediation – Innovative Treatment Technologies

When faced with the problems of remediation of hazardous waste sites, managers and specialists need information to help them in selecting the technology best suited to their particular problem. This book provides such guidance, based on two series of U.S. government reports: one from the U.S. Environmental Protection Agency, the other from the Naval Energy and Environmental Support Activity. The individual chapters describe various technologies and give appropriate technical data on a wide range of methods for containment and treatment of wastes on abandoned sites. Subjects covered include: containment, biological treatment, physical chemical extraction techniques, thermal processes, advanced oxidation processes, and more. The book is well illustrated and will be a useful guide for remediation project managers, site engineers and coordinators, and contractors.

Harry M. Freeman and Eugene F. Harris, eds. Technomic Publishing Co., Inc., 851 New Holland Avenue, P.O. Box 3535, Lancaster, PA 17604, USA. Tel: +1 (717) 291 5609, Fax: +1 (717) 295 4538. Pbk. 342p. ISBN 1-56676-301-0.

1995 International Incineration Conference Proceedings

The full text of the proceedings of the International Incineration Conference, held 8-12 May 1995, is now available.

The papers contained in this comprehensive document cover many aspects of the thermal treatment of radioactive, hazardous chemical, mixed, munitions and pharmaceutical wastes. Subjects range from overall system design to the behaviour of individual waste components during incineration.

University of California, Irvine Office of Environment, Health and Safety, Irvine, California 92717-2725. Tel: +1 (714) 824 5859, Fax: +1 (714) 824 8539. Pbk. 783p.

Waste Management for Sustainable Development in India – Policy, Planning and Administrative Dimensions

The Indo-Canadian Kanpur Research Project, on which *Waste Management for Sustainable Development in India* is based, aims to demonstrate that it is possible to reconcile industrialisation and sustainability in India. Kanpur is a major industrial centre in the north of India. The industries present fall into three categories: textile mills and tanneries in the inner area; defence industries, iron and steel works and chemical plants in outlying industrial areas; and electrical, base metal, agricultural implements and fertiliser industries on outlying, planned industrial estates. Virtually all of this industry has grown up with little or no concern for environmental issues.

In countries like India, the pressure of rapidly rising populations and an urgent need for development can appear as irreconcilable with sustainable development. The Kanpur Research Project recognises that this contradiction between environmental protection and economic development needs to be addressed if sustainable development is to be seriously pursued. An axiom for the project is that minimising of this contradiction requires fundamental structural, conceptual and process changes in policy and planning institutions.

In order to address both the technical and institutional aspects of sustainability, the Kanpur project "seeks to define a public and planning framework that actively promotes the adoption of Low Waste Technologies (LWT)." *Waste Management for Sustainable Development in India* traces the history of the project to date. The book first describes the context and background to the project and then presents technical case studies showing how LWTs can be applied to particular sectors of industry. In later sections institutional and economic aspects of application of LWTs are examined and the book ends with a look at prospects for the future.

Nonita T. Yap and Shailendra K. Awasthi, eds. Tata McGraw-Hill Publishing Company Limited, 4/12 Asaf Road, New Delhi 110 002, India. Hbk. 396p. ISBN 0-07-462499-7.

IPCS Environmental Health Criteria publications and Health Safety Guides

The International Programme on Chemical Safety (IPCS) is a joint venture between UNEP, the International Labour Organisation and the World Health Organization (WHO). Publications in the Environmental Health Criteria (EHC) series review the environmental and health effects of exposure to a chemical or group of chemicals and provide guidelines for setting exposure limits. The Health and Safety Guide (HSG) series facilitates the application of these guidelines in national chemical safety programmes. The books are in English (those in the EHC series have summaries in French and Spanish), are priced in Swiss francs (shown here) or US dollars, and are available at a discount in developing countries. The series is available from WHO, Distribution and Sales, CH-1211 Geneva 27, Switzerland, and from sales agents for WHO. The most recent titles are:

EHC 169 – Linear Alkylbenzene Sulfonates and Related Compounds *(1996). Pbk. 328p. ISBN 92-4-157169-1. SF 47.00.*

EHC 178 – Methomyl *(1996). Pbk. 150p. ISBN 92-4-157178-0. SF 23.00.*

EHC 179 – Morpholine *(1996). Pbk. 163p. ISBN 92-4 157179-9. SF 27.00.*

HSG 100 – Cresols *(1996). Pbk. 24p. ISBN 92-4-151100-1. SF 3.50.*

HSG 101 – Hydroquinone *(1996). Pbk. 32p. ISBN 92-4-151101-X. SF 5.00.*

Integrated Regional Risk Assessment: Volumes 1 and 2

Volume 1, subtitled *Continuous and Non-Point Source Emissions: Air, Water, Soil*, highlights the main procedures for assessment of risks for health and the environment from continuous emissions of pollutants into the air, water and soil.

Volume 2, subtitled *Consequence Assessment of Accidental Releases*, is concerned with the assessment of the consequences of accidental releases.

Swiss Federal Institute of Technology Zurich, Weinbergstrasse 11, CH-8001, Zurich, Switzerland. Tel: +41 (01) 632 5938, Fax: +41 (01) 632 1094. Hbk. Vol. 1, 343p. Vol. 2, 349p.

Quantative Risk Assessment of Hazardous Materials Transport Systems (tTopics in Safety Risk Reliability and Quality, Vol. 5)

This book highlights the main procedures for assessing the regional risks resulting from storage of dangerous goods and their transportation by various systems (road, rail, ship, pipeline, etc.).

Michel Nicolet-Monnier and Adrian V. Gheorghe. Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. Hbk. 343p. ISBN 0-7923-3923-1.

Air Pollution Control Technology in Japan and Waste Treatment Technology in Japan

These two reports from the Global Environment Centre Foundation (GEC) give examples of technical solutions to problems of air pollution and waste treatment in Japan. Many of the solutions implemented use simple technologies, suitable for transfer to developing and transition-economy countries.

Available from: Global Environment Centre Foundation, 2-110, Ryokuchikoen, Tsurumi-ku, Osaka 538, Japan. Tel: +81 (6) 915 4121, Fax: +81 (6) 915 0181. Pbk. 250p.

RECYCLING

R'95 Congress Proceedings

The collected papers of the R'95 Recovery, Recycling, Re-integration Congress, held in Geneva in February 1995, are now available in five volumes:

Volume 1: Concepts, Life Cycle Analysis, Legal and Economical Instruments. *Pbk. 367p. ISBN 3-905555-01-8.*

Volume 2: Design for Avoidance. *Pbk. 209p. ISBN 3-905555-02-6.*

Volume 3: Mechanical Processes. Logistics Networks. Separation Technologies. *Pbk. 398p. ISBN 3-90555-03-4.*

Volume 4: Chemical Processes. Biological Processes. Hospital Waste. *Pbk. 325p. ISBN 3-905555-04-2.*

Volume 5: Thermal Processes. Energy Recovery. *Pbk. 240p. ISBN 3-905555-05-0. ISBN complete edition 3-905555-00-X.*

EMPA. Uberlandstrse 129. 8600 Dubendorf. Switzerland.

BIODIVERSITY

Balancing the Scales: Guidelines for Increasing Biodiversity's Chances through Bioregional Management

Can the world's parks and natural areas be prevented from becoming "storm-battered islands of biological diversity in a sea of human settlements"? This is the question addressed in the World Resources Institute's report *Balancing the Scales*. In it, the author draws on concepts and practical experience from around the world to support scientists' and practioners' contention that our conservation and resource management programmes need to embrace whole ecosystems or "bioregions", and that such activities must be integrated from the early planning stages to preserve biodiversity.

The growing convergence among social, economic and ecological approaches is examined and examples of bioregional management in various parts of the world are given, to illustrate typical obstacles encountered by the leaders and communities involved in these programmes. The lessons learned from these experiences provide insights for local communities, scientists, resource managers and government officials, for preparation of their own bioregional efforts.

By Kenton R. Miller. World Resources Institute. 1709. WRI Publications. P.O. Box 4852. Hampden Station, Baltimore. MD 21211. USA. Pbk. 73p. ISBN 0-915825-85-6.

DIRECTORIES

Global Management 1996: Russia and CIS

The 12th annual edition of *Global Management*, from the Management Centre Europe, is a comprehensive guide for businesses seeking contacts in Russia and the CIS. Presentations of individual companies and trading organizations are combined with overview articles on a wide range of subjects including "Addressing Environmental Issues".

Management Centre Europe, Rue de l'Aqueduc 118, B-1050 Brussels, Belgium. Tel: +32 (2) 543 2100. Fax: +32 (2) 543 2400. Pbk. 637p.

The Environmental Business Directory – Environmental Service and Technology Providers in the Czech Republic, Hungary, Poland and the Slovak Republic

This directory contains detailed information about 700 companies involved in environmental activities in the "Visegrad" countries (Czech Republic, Hungary, Poland and the Slovak Republic). In a first section companies are classified, in tables, by area of expertise. Full details of each company are contained in a second section. The information is given in English and in the four countries' languages.

The Regional Environmental Center for Central and Eastern Europe, Miklos ter 1, 1035 Budapest, Hungary. Tel: +36 (1) 250 3401. Fax: +36 (1) 250 3403. Pbk. 255p. ISBN-963-8454-25-3.

EDITIONS FRANCAISES

Le guide de l'eau : Edition 1996-1997

L'eau est un élément essentiel pour la vie. *Le guide de l'eau* aide ses lecteurs à cerner les problèmes institutionnels, techniques et économiques posés par la gestion moderne de cette ressource vitale.

La première section du guide est consacrée au cadre institutionnel. Elle recense les organismes publics, du niveau international au niveau local, ayant compétence dans le domaine de l'eau.

La deuxième section est la partie annuaire du guide. Elle fournit les coordonnées des pouvoirs publics, des organismes d'étude et de recherche, des associations et des organismes de formation. Elle contient également, une liste de publications françaises et étrangères.

La section III, intitulée « Les Données », donne des informations chiffrées concernant les Agences de l'eau et leurs programmes d'intervention.

La section IV regroupe les offres de biens et de services dans le domaine de l'eau, au moyen d'un répertoire alphabétique et d'un répertoire thématique des fournisseurs et de prestataires de service.

Pierre Johanet & Fils Editeurs S.A., 30 rue René Boulanger, 75010 Paris, France. Tel: +33 (01) 42 40.00.08, Fax: +31 (01) 42.40.26.46. Hbk. 1040p.

Stratégies d'utilisation rationnelle de l'énergie en Afrique de l'Ouest

Cet ouvrage présente une analyse des problèmes énergétiques et environnementaux des pays membres de la Communauté Economique de l'Afrique de l'Ouest (Bénin, Burkina Faso, Côte d'Ivoire, Mali, Mauritanie, Niger et Sénégal). Sur le plan énergétique, ces pays se caractérisent par une consommation de combustible ligneux supérieure à 70 pourcent de la consommation finale d'énergie et par une dépendance totale de l'extérieur pour leurs approvisionnements en hydrocarbures. Les conséquences de telles pratiques sont une pression constante sur l'environnement et l'accroissement de l'endettement extérieur, frein majeur du développement.

L'analyse, qualifiée par les auteurs de « duale », retrace les grandes lignes des politiques d'utilisation rationnelle de l'énergie spécifiques à chaque pays et se poursuit par des études de cas de deux pays : Burkina Faso et Côte d'Ivoire.

Enda Tiers Monde, Service Publications, B.P. 3370, Dakar, Sénégal. Fax: +221 23.51.57/ 22.26.95. Poche. 122p. ISBN 92-9130-007-1.

Rapport d'activité : Direction de la prévention des pollutions et des risques

La Direction de la prévention des pollutions et des risques du Ministère de l'Environnement de la France vient de publier son rapport d'activité pour l'année 1995, ainsi qu'une deuxième rapport intitulé *Les principaux rejets industriels en France*. Ce dernier donne des détails des rejets de polluants industriels en France et dans les dépqrtement d'outre-mer, sous forme de tableaux et cartes géographiques.

Ministère de l'Environnement, Direction de la Prévention des Pollutions et des Risques, 20 avenue de Ségur, 75302 Paris 07, France. Tel: +33 (1) 42 19 20 21. Poche. 86p et 205p.

Industrie, environnement et communication : Guide pratique pour les sites industriels

Le but de ce guide est d'aider les chefs d'entreprise ou d'établissement à prendre en compte, dans leurs objectifs, leurs politiques et leurs actions, les attentes et exigences du corps social et des pouvoirs publics, en matière d'information et de communication sur le respect de l'environnement.

Entreprises pour l'Environnement, 5 esplanade Charles-de-Gaulle, 92733 Nanterre Cedex. Tel: +33 (01) 47.24.64.55. Fax: +33 (01) 47.24.61.77. Poche, 69p. ISBN 2-9508030-3-2.

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AWARE is prepared and published in collaboration with UNEP's International Register of Potentially Toxic Chemicals (IRPTC). Comments on the present series of AWARE articles are welcome and should be sent directly to UNEP/IRTPC, 15 Chemin des Anémones, Case Postale 356, Châtelaine, CH-1211 Geneva, Switzerland.

Site selection for new hazardous waste management facilities

In 1983, at the end of a long series of activities related to municipal and hazardous wastes, the World Health Organization (WHO) Regional Office for Europe joined forces with the United Nations Environment Programme (UNEP) to publish a volume on the management of hazardous waste. This book became a landmark reference for establishing policy guidelines and a proper code of practice.

As a follow-up, the WHO Regional Office for Europe recently published a guide on "Site Selection for New Hazardous Waste Management Facilities". This guide outlines the processes involved in selecting appropriate sites where new facilities can be set up to manage hazardous waste properly. It also deals extensively with the importance of social acceptability. Facilities, for example, have been less controversial and the outcome of siting processes more predictable in Europe than in North America, but there is a trend towards greater challenges to new facilities in Europe. In future, the European experience may be more like that of North America.

While this guide is based on experience in industrial countries, much of it also applies to developing countries. For example, a facility development checklist contains points that are applicable, with minor differences, to any facility. Where technical resources are in short supply, especially in developing countries, a problem with execution is likely. In a technically unsophisticated country, emphasis should be placed on basic units and the quality of their operation, with more advanced technology phased in as the economy and human resources permit.

Waste reduction and recycling, which are associated with economic efficiency and the conservation of resources, should be an integral part of industrial operations in any type of economy. Neither in developing nor developed economies should uneconomical waste reduction practices be forced on industry. Despite the different social and economic context of developing countries, the siting processes described in this guide contain "building blocks" adaptable to most situations. Support and opposition to siting are based on universal human concerns. The guide calls for social values to be identified where the local community is inarticulate or weak, whether the siting process is taking place in the developing or developed world.

This guide touches on all elements of facility siting and gives equal weight to the social impacts, and the engineering and scientific considerations, involved. It advocates using a voluntary process that relies on public support and acceptance of the need for the facility. The guide goes so far as to state that the public's acceptance of the siting process as valid and fair is vital. The community that will play host to the facility should be viewed as a resource rather than an adversary. More facilities have been sited successfully with the participation of the community than through authoritative approaches. Without this support, the siting process may fail.

Drawing on practical examples, the guide outlines essential planning considerations and model siting procedures for hazardous waste facilities of all types, for the use of governments, industry, environmental and public interest groups and the general public, including critics of and parties to negotiation on site selection.

Waste management and facility needs

For environmental and economic reasons, there is a need for a hierarchy of measures for waste management that includes reduction at the source, reuse, incineration for energy recovery, recycling, treatment by thermal, chemical, biological or physical technology, and secure containment of treatment residues or unreactive wastes. The use of this hierarchy is second in priority only to the abatement of uncontrolled discharges, and may in fact be the most economical means of abating many discharges. Reducing and recycling waste at the source tends to improve industrial productivity and reduce emissions instead of shifting them between air, soil and water. Securing state-of-the-art treatment or containment technology is third in priority.

Facilities of adequate capacity, number and operational quality should be available in areas with significant arisings. The failure to provide facilities leads to uncontrolled disposal, with substantial later damage and clean-up costs. Public authorities in all countries are responsible for promoting the development of facilities, although they will not achieve this goal in the same way or at the same time. Highly industrialized countries should have state-of-the-art systems to manage hazardous waste, although even modest facilities are greatly preferable to none at all. In general, this guide focuses on new, independent facilities. Circumstances, however, may require gradual development or the adaptation of existing facilities. In any case, an ideal site is seldom available.

Successful siting requires that the public thoroughly understand and accept both the need for a proposed facility and how it will operate. The question of need involves complex technical, economic and policy judgements concerning available capacity, spare capacity, technological development, geographical location and transport, competition, and economic circumstances. Calculations of supply and demand are useful in determining the capacity needed, but are limited by shortcomings in data and in the ability to predict technology trends. There is no universally useful set of data on waste arisings. Lengthy data acquisition or the failure to implement a programme to reduce and recycle waste at the source should not stall the development of a facility.

Adequate regulation is fundamental to hazardous waste management and hence to facility development. The discussion of regulatory matters, however, is beyond the scope of this guide.

Siting processes

A voluntary siting process, including vigorous information programmes for the public and politicians, is recommended. Facility siting through a voluntary process involves searching for suitable locations, ensuring public support and acceptance of the need and the location, and licensing of the facility by government. It is not a process of meeting minimum standards. The public's acceptance of the siting process as valid and fair is of basic importance.

A voluntary process is based on three points. The first is equity. People should have a voice in matters that affect them. The second is economic efficiency. Community participation is likely to lead to remedies, including compensation, for potential losses that are often overlooked, while attending to the needs of industry. The third point is success. While a voluntary process may result in the defeat of some proposals and the modification of others, effective public participation and support are compromised if overriding government authority is too readily available or if decisions are seen as determined in advance.

Participation measures should be used to define important conditions that may not be covered by government regulation. Blaming the prospective host community for trying to protect the welfare of their families, homes and surroundings is not only unfair, but unrealistic and impractical in terms of development strategy. Of course technical adequacy is essential, but by itself it guarantees neither acceptance nor equity. The community must believe with reason that a proposed facility will be managed safely and that adverse effects can be remedied without damage to the environment and the community. Compensation or incentives, however, do not constitute a basis for local support. Particularly when the host community is inarticulate about its planning and goals, close attention needs to be paid to potential social and economic impacts, as well as to effects on health and the environment.

Site selection using the technical model provided in the guide anticipates that the most suitable location will be selected from among candidate sites. These sites are screened for suitability, but may have different and not necessarily comparable characteristics and degrees of suitability. The technical model is usually associated with siting decisions made at the regional or national level, in contrast to the voluntary approach in which decisions are made at the local level.

Informed public comment and consent are the main principles advocated by this guide. Hence an active programme to inform interested parties and the mass media about a proposed facility is essential. Interested members of the public often obtain information on their own, and should be encouraged and assisted to do so. An information programme provides a basis for a common understanding of the issues and a means to build communication and trust. The release of adverse as well as favourable information furthers this. Information that may be embarrassing later should be released early. Technical issues should be explained in terms comprehensible to the mass media, decision-makers and the public. Attention and resources should be devoted to this task. While no information programme will reach as many people as the mass media, the media nevertheless seldom provide sustained or in-depth coverage. The timing, volume, quality, balance and objectivity of information made available to the mass media are therefore extremely important.

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Industry and Environment in a Chinese version

Since 1991, the *Industry and Environment* review has been published in a Chinese version, with Prof. Qu Geping, Chairman of China's National People's Congress Commitee on Environment and Natural Resource Conservation, as Chief Editor. It is finding ways to reach more and more readers. In addition to the dissemination of most copies through the National Post Office Distribution Network, a large number of copies of every issue are sent, on a regular basis, to the leaders and relevant personnel of the Chinese Academy of Sciences and governmental agencies, including the NPC's Committee of Natural Resources and Environmental Protection, the National Environmental Protection Agency, the National Natural Sciences Foundation, the State Science and Technology Commission, and so on. We frequently receive letters requesting this review from individual readers who know it from a library or from their friends. They are automatically included on our regular mailing list. Furthermore, many copies have been distributed to participants attending various meetings or seminars/workshops, particularly those held in our RECESS/CAS.

Recently, 500 copies of the issue on "Sustainable Tourism Development" were requested by the National Tourism Agency, which expressed great interest in the content. A large number of copies of the issue on "Transport and the Environment" were requested by the Institute of Road Transportation, Ministry of Transportation, to distribute to related sectors. The Department of Pollution Management, NEPA, ordered 1000 copies of the issue on "Cleaner Production" to use as material in their training courses. Many educational institutions, such as Tsinghua University in Beijing and the Northeast University of Polytechnics in Shen'yang, Liaoning, are also very interested. People from these universities frequently come to our office to find documents, including the review and its supplements, which may be useful in their research. Some of the lecturers have even incorporated articles, such as those related to Cleaner Production, into their own teaching materials.

Prof. Qu Geping

Prof. Chen Dingmao, Vice-Chief Editor

Anyone who has read it says finding a publication like *Industry and Environment*, in which one can quickly obtain overall knowledge of what is happening in various environmental protection fields worldwide and learn a lot from good experiences, new concepts and emerging technologies, is difficult in this country at present. The review has indeed been considered a good publication by many institutions such as the Xinhua News Agency (a Chinese official news agency), the Jinaly County's Institute of Science and Technology Information in Eubei Province, and the Laiwu Iron and Steel Complex in Shandong Province. Recently the Administration Planning Commission for China's Agenda 21 informed us that *Industry and Environment* in Chinese will be used as training material in their future courses.

Pride in the achievements mentioned above is deserved, because your good publication has been delivered to more and more readers through our efforts. For more than five years, it has continued to be disseminated increasingly all around this country, reaching into an increasing number of fields, and becoming well known by more and more people. Certainly there is still much more we can do. For example, we will make more efforts to publicize the review and to further improve the quality of printing of the Chinese version at a lower cost. Beginning this year, the cover page will be printed in a blue colour. Due to limited funding, the other pages can only be printed in black and white. However, we will make every effort to match the printing quality and colours of the original.

Prof. Chen Dingmao
Director Information Division
Research Center for Eco-Environmental Sciences
Academia Sinica
PO Box 2871, Beijing 100085
People's Republic of China

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Water leakage

In the article "Kunert's environmental management tools" (*Industry and Environment* Vol. 18, N° 2-3, pp 28-31) the writer states that "[Kunert] employees performed a systematic check and uncovered the leak [of] 50,000 m^3 of water per day..."

Fifty thousand cubic metres is 50 million litres: a little over 11 million gallons. By comparison, the most populous city in Pakistan, Karachi (population 12 million), gets by with a mere 300 million gallons per day.

Given the apparently massive disparity between the figures, perhaps there was a mistake in the figure quoted in Kunert's article: or does it relate to a certain period?

Mohammad Irshad Piracha
Environment Watch
119 Str 42, F10/4, Islamabad
Pakistan

Editor's note: *The author of the article referred to has kindly agreed to respond to the point Mr Piracha raises. Mr Kreeb's response appears below.*

The figure of 50,000 m^3 per "day" was a misprint. The figure of fifty thousand cubic meters was the *annual* volume of water resulting from the leak. It was this, a less dramatic but still substantial environmental problem, that had to be solved.

I want to wish Mr Piracha success in improving the environmental situation in his country.

Martin Kreeb
Department of Environmental Management System
Kunert AG
Julius-Kunert Str. 49, D-87509 Immenstadt
Germany

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Correction: *The authors of the article "Industrial pollution inventory and management in Nepal" published in Vol. 19, N°1 have asked us to publish the following correction: The name of the project is the Industrial Pollution Control Management Project (NEP/91/029). It is financed by UNDP, executed by UNIDO, and implemented by the Ministry of Industry, His Majesty's Government of Nepal.*

THE ROLE OF UNEP INDUSTRY AND ENVIRONMENT

It is now widely accepted that sustainable development and a sound environment go hand-in-hand. UNEP recognized this as early as 1975 when it established the Industry and Environment centre (IE), located in Paris. UNEP IE functions as a catalyst to bring industry, government and non-governmental organizations together to work towards environmentally sound forms of industrial development. UNEP IE seeks to:

◆ define and encourage the incorporation of environmental criteria in industrial development;

◆ help formulate policies and strategies for sustainable industrial development and facilitate their implementation;

◆ promote preventive environmental protection through cleaner production and other pro-active approaches; and

◆ stimulate the exchange of information on environmentally sound forms of industrial development.

To achieve these goals, UNEP IE has developed programmes in the fields of Awareness and Preparedness for Emergencies at Local Level (APELL), Cleaner Production, Tourism and Transport, and other sector-specific activities. The OzonAction Programme, under the Multilateral Fund, is also based at UNEP IE. UNEP IE organizes conferences and seminars, undertakes training activities and demonstration projects, and produces practical supporting publications.

To promote the transfer of information and experience, UNEP IE has developed:

◆ The *Industry and Environment* quarterly review;

◆ A *Query-Response Service*, which responds to specific technical queries on a wide range of subjects related to industrial pollution;

◆ *Outreach Activities*, which address a broad range of issues concerning industry as a whole. UNEP IE develops partnerships with industry, government and non-governmental organizations, organizes consultative meetings, and publishes supporting documents aimed at spreading new developments in the field of sustainable development.

◆ A *Technical Report Series* and other publications, which provide practical information to readers throughout the world. Recent titles include *Cleaner Production Worldwide, Hazards Identification in the Local Community, From Regulations to Industry Compliance: Building Institutional Capabilities, Audit and Reduction Manual for Industrial Emissions and Wastes, Companies Organization and Public Communication on Environmental Issues*, and many others. For a complete list of available publications, please contact UNEP IE.

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FEEDBACK

If you would like to respond to something you've read in these pages — to agree or to take issue with a point of view, to clarify a point of fact, or to provide information on a particular aspect — write to us. If you would like to air your views on any other subject relevant to ***Industry and Environment***, we would like to hear from you. As space is limited, we cannot guarantee to publish all letters, nor to publish long ones in full.

Send your Feedback letters to:

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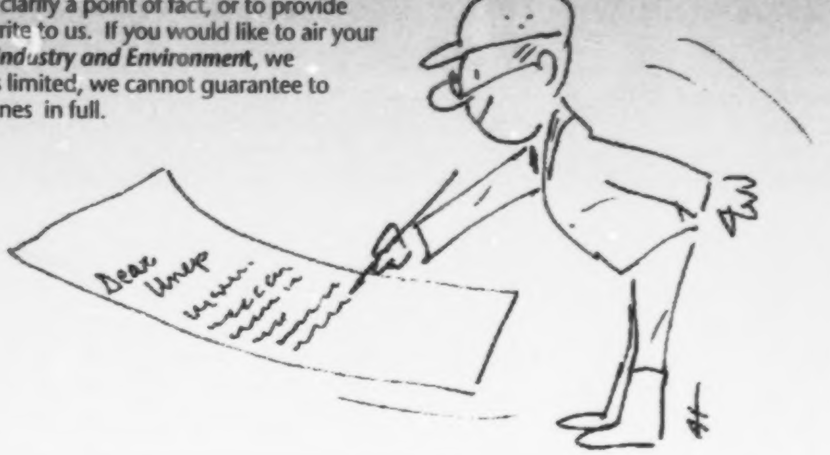

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The review is now also available in Chinese translation. For further details, please contact: Professor Chen Dingmao, Research Center for Eco-Environmental Sciences, Academia Sinica, P.O. Box 2871, Beijing 100085, China.

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